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May 10, 2010
(PBW Project No. 1352)

VIA COURIER

Mr. Gary Miller
Remedial Project Manager
U.S. Environmental Protection Agency, Region 6
Superfund Division (6SF-RA)
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Ms. Barbara Nann
Assistant Regional Counsel
U.S. Environmental Protection Agency, Region 6
Superfund Division (6RC-S)
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

RE: FINAL BASELINE ECOLOGICAL RISK ASSESSMENT PROBLEM FORMULATION AND FINAL BASELINE ECOLOGICAL RISK ASSESSMENT WORK PLAN & SAMPLING AND ANALYSIS PLAN GULFCO MARINE MAINTENANCE SUPERFUND SITE FREEPORT, TEXAS

Dear Mr. Miller and Ms. Nann:

Please find enclosed three (3) copies (Mr. Miller) and one copy (Ms. Nann) of the Final Baseline Ecological Risk Assessment (BERA) Problem Formulation (PF) and Final BERA Work Plan & Sampling and Analysis Plan (WP-SAP) for the Gulfco Marine Maintenance Superfund Site. These documents were prepared in response to comments on previous drafts (dated March 10, 2010) as provided in your letter dated April 14, 2010. The April 14, 2010 comments and corresponding responses are provided in Attachment A to this letter. Redline-strikeout versions of the report text (generated through the Microsoft Word® "Compare Documents" feature) are provided in Attachment B (for the BERA PF) and Attachment C (for the BERA WP-SAP) to this letter.

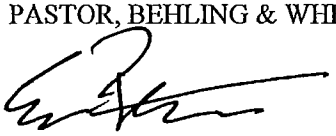
The enclosed documents were prepared by URS Corporation (URS) on behalf of LDL Coastal Limited LP (LDL), Chromalloy American Corporation (Chromalloy) and The Dow Chemical Company (Dow). In accordance with Paragraph 52 of the amended Unilateral Administrative Order for the Site, effective January 31, 2008 (the amended UAO), I certify that I have been fully authorized by these Respondents to submit these documents and to legally bind these Respondents thereto.

Paragraph 13 of the Statement of Work attached to the amended UAO requires an electronic copy of project deliverables be provided in WordPerfect® format. However, as requested by Mr. Miller for previous project deliverables, electronic copies of the text of the enclosed documents are provided in Microsoft Word® format and the other document components are provided in Adobe® format instead. A DVD with these electronic files is transmitted herewith to Mr. Miller.

Thank you for the opportunity to submit these documents. Should you have any questions, please do not hesitate to contact me at any time.

Sincerely,

PASTOR, BEHLING & WHEELER, LLC



Eric F. Pastor, P.E.
Principal Engineer

Enclosures

cc: Ms. Luda Voskov – Texas Commission on Environmental Quality (2 copies)
Mr. Doug McReynolds – EA Engineering, Science and Technology
Ms. Jessica White – National Oceanic and Atmospheric Administration
Mr. Ron Brinkley – US Fish and Wildlife Service
Mr. Don Pitts – Texas Parks and Wildlife Department
Mr. Andy Tirpak – Texas Parks and Wildlife Department
Mr. Tommy Mobley – Texas General Land Office
Mr. John Wilder – Texas Commission on Environmental Quality
Mr. Larry Champagne - Texas Commission on Environmental Quality

bcc: Mr. Brent Murray – Environmental Quality, Inc.
Mr. Ray Merrell – Sequa Corporation
Mr. Donnie Belote – The Dow Chemical Company
Mr. Allen Daniels - LDL Coastal Limited, LP (w/o enclosure)
Mr. F. William Mahley - Strasburger & Price, LLP
Mr. James C. Morriss III - Thompson & Knight, LLP
Ms. Elizabeth Webb - Thompson & Knight, LLP
Mr. David Lingle – URS Corporation

ATTACHMENT A

RESPONSES TO APRIL 14, 2010 COMMENTS ON
DRAFT BERA PROBLEM FORMULATION AND DRAFT BERA WORK PLAN &
SAMPLING AND ANALYSIS PLAN DATED MARCH 10, 2010

Attachment A

Response to EPA and TCEQ April 14, 2010 Comments on Draft BERA Problem Formulation and Work Plan & Sampling and Analysis Plan

Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
44 (SLERA comment)	The Refinement shall be checked if there was another reason that the HQ for lead for the sandpiper fell below unity besides the accepted use of the average body weights.	The Final SLERA submitted on May 4, 2010 showed an HQ less than one (1) for the sandpiper and lead.
1	The document is difficult to follow. The document shall be reorganized based on Areas/Receptors. For example, address soil invertebrate toxicity in South Area Soil separately from other areas. All appropriate issues could be addressed independently using this approach (e.g. background, refined exposure scenarios, site-specific aspects that affect decisions), and the areas addressed one by one following the order presented in Table 29 from the SLERA.	The Final BERA Problem Formulation document has been streamlined. Draft BERA Problem Formulation (March 10, 2010) Appendices C through H, which were focused primarily on higher trophic level receptors, were removed after the Final SLERA (submitted May 4, 2010) concluded that there are no unacceptable risks to higher trophic level receptors. The revised Table 29 from the Final SLERA (submitted May 4, 2010) was included as Appendix A in the Final BERA Problem Formulation.
2	Fish shall be included in Tables 4 and 5 for assessment and measurement endpoints receptors in the Problem Formulation. It would be agreed that a toxicity test using the mysid shrimp would be protective of fish since the mysid would likely be more susceptible to exposure, but only if it can be documented that ammonia is not an issue. If ammonia (from any barge cleaning agents or other site-related source) is potentially an issue, then, in addition to the mysid shrimp toxicity test for the water column, there would also need to be an inland silverside fish toxicity test proposed (since fish are sensitive to ammonia). This shall be explained and documented.	The fish community has been added to Tables 3 and 4 (formerly Tables 4 and 5) of the Final BERA Problem Formulation, and Table 1 of the Final BERA Work Plan/SAP. A detailed discussion of the Site history, including barge cleaning operations, was provided in Section 2.2 of the RI/FS Work Plan. None of the information presented therein, or the project documentation reviewed for preparation of that work plan, indicated that ammonia was used as part of barge cleaning or other Site operations. As a result, ammonia was not identified as a chemical of potential concern for the Site and thus is not proposed as a consideration for fish toxicity testing.
3	One of the SDMPs at the end of the SLERA says that there is potential adverse impact on sedentary invertebrates in soil (South and North Areas), and that more assessment is warranted in Step 3. Earthworm toxicity tests (as representative of soil invertebrates) shall be proposed for the BERA Problem Formulation and Work Plan/Sampling and Analysis Plan (SAP). And, regarding page 9 of the Problem Formulation, this shall also be done for the South soil area since engineered fill and side embankments can constitute habitat for soil invertebrates (a complete pathway).	A Removal Action WP has been finalized and is ready to be implemented upon execution of the Removal Action Settlement Agreement. The Final BERA Work Plan/SAP proposes that implementation of the removal action in the North Area, as well as the nature of the disturbed habitat in the South Area and past, current, and anticipated future land use (including restrictive covenants for only commercial/industrial land use), obviates the need for further consideration of soil exposure pathways in the Final BERA Work Plan/SAP.

Attachment A

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Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
4	Another SDMP at the end of the SLERA states that there are localized adverse effects on sedentary benthics in sediment with exceedances of the midpoint between the ERL and ERM. The samples proposed for the Work Plan and SAP for the BERA shall not be limited to those locations where there were exceedances of midpoints, but also shall include locations where ERLs were exceeded but below the midpoints (between ERLs and ERMs).	The proposed sediment sample locations in the Final BERA Work Plan/SAP include multiple locations with COPEC-specific HQs above a TCEQ benchmark ("ERLs") and below a corresponding TCEQ second effects level ("ERMs"). Note that the Final BERA Work Plan/SAP incorporates moving the previously proposed sediment sample EWSED03 approximately 150 ft to the northwest (from RI/FS location NC4SE12 to NC3SE11) to allow evaluation of lower level concentrations of site COPECs.
5	For the Problem Formulation, the appended tables (G-6) for the Refinement of COPECs evaluation did not include lead in the table for the sandpiper evaluation as implied by the SDMP at the end of the SLERA. Lead shall be included.	The Final SLERA (submitted May 4, 2010) concluded that there are no unacceptable risks to higher trophic level receptors. The Final BERA Problem Formulation has been modified accordingly by removing Appendices C through H.
6	In the Problem Formulation, the contaminants listed in appended tables for the Refinement of COPECs for the sandpiper and green heron shall not exclude contaminants eliminated from the SLERA based on comparison to ERLs for benthic receptors. Tables shall be provided which include all the analytes by receptor and area of concern with columns indicating which contaminants were eliminated in each of the steps (with the SLERA as the starting point) and which include the rationale for elimination in order to summarize this information.	The Final SLERA concluded that there are no unacceptable risks to higher trophic level receptors. The Final BERA Problem Formulation has been modified accordingly by removing Appendices C through H (which contained the tables referenced in this comment).
7	For Table 4 in the Problem Formulation (and Table 1 in the Work Plan/SAP), the testable hypotheses for the toxicity tests shall include statistical language regarding the Type I error (i.e., significance levels, p statements).	Sediment sampling locations have been proposed in the Final BERA Work Plan/SAP. The diversity of location and COPECs should allow for a reasonable expectation that the results will show an assessment of site-specific toxicity and therefore ecological risk.
8	Tables 4 and 5 in the Problem Formulation (and Table 1 in the Work Plan/SAP) shall list fish in the aquatic guild being protected.	The fish community has been added to Figures 4 and 5 of the Final BERA Problem Formulation, and Table 1 of the Final BERA Work Plan/SAP.
9	Table 1 in the Work Plan/SAP shall incorporate the toxicity	The proposed toxicity tests, assessment endpoint receptors, and

Attachment A

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Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
	tests to be conducted to evaluate risk and identify the assessment endpoint receptors for which the toxicity tests are representative. Also, the test endpoints shall be stated such as survival, growth, and reproduction for Leptocheirus; survival, growth, and egg development for the mysid shrimp; and survival and growth for Neanthes. Bioaccumulation data shall be collected at the end of these tests.	test endpoints have been added to Table 1 of the Final BERA Work Plan/SAP. Collection of bioaccumulation data was not included in the Final BERA Work Plan/SAP since the proposed toxicity tests are considered sufficient for evaluating toxicity to these test organisms.
10	Despite a corresponding SDMP for soil invertebrates, soil invertebrates are missing, and shall be included. The Problem Formulation text, Tables, and Figures shall include toxicity testing (earthworm) for addressing soil invertebrate toxicity, which was identified as a SDMP in the SLERA. Depths of sampling for the toxicity test shall be matched to the depth for analytes and bioavailability parameters.	Soil invertebrate toxicity testing is not proposed in the Final BERA Problem Formulation or the Final BERA Work Plan/SAP. See response to Comment #3.
11	Problem Formulation, page vi, first paragraph under the bullets: The words "consideration of background metals concentrations" shall be removed. Background shall not be used to not propose metals for quantification and further consideration in the BERA in this instance because the receptors requiring further evaluation (benthic receptors and soil invertebrate receptors) are sedentary. Also, hot spots of metals (with HQ exceedances of unity with contribution from both site and background sources) could be missed for cleanup recommendations; this would thus be inadequately protective for these sedentary receptors. For example, there are some locations where potential hotspots for zinc would be missed if the sampling strategy included locations tailored only to PAHs and pesticides. This is especially the case since the EPA guidance used for determining statistically significant differences between site background locations is a statistical (ANOVA) comparison to mean concentrations. For sedentary receptors, maxima concentrations are needed. Metals shall remain in the Problem Formulation (and Work Plan/SAP) for quantification for the BERA. Any text language, Tables, Figures, and Appendices affected by this comment shall be	The comparison of means test used in the Problem Formulation demonstrates that the site soil invertebrate community as a whole would not be at any greater risk due to metals exposures than an offsite population. The majority of site metal concentrations that were screened from further evaluation using the comparison of means test are also below maximum background concentrations. The background screening performed is therefore considered to be protective for sedentary receptors.

Attachment A

Response to EPA and TCEQ April 14, 2010 Comments on Draft BERA Problem Formulation and Work Plan & Sampling and Analysis Plan
Gulfco Marine Maintenance Superfund Site
Freeport, Brazoria County, Texas

Comment No.	Comment	Response
	revised.	
12	Page 6 of the Problem Formulation, Section 2: The Refinement needs to identify that the modifications used apply only to evaluation of food web risks.	This information has been removed from the Final Problem Formulation since the Final SLERA (submitted May 4, 2010) concluded that there are no unacceptable risks to higher trophic level receptors.
13	Page 7, Section 2.1 Refined Procedures and Results: The reference to "Appendices C through J" shall be to "Appendices C through G".	The majority of the information included in Appendices C through H of the Draft Problem Formulation was related to higher trophic level receptors. This information has not been included in the Final Problem Formulation since the Final SLERA (submitted May 4, 2010) concluded that there are no unacceptable risks to higher trophic level receptors.
14	P. 8, Section 2.1 Refined Procedures and Results: The refined lead HQ for the sandpiper could not be confirmed as lead was not evaluated in Appendix G. Lead shall be evaluated in Appendix G. Also see related SLERA comments.	The Final SLERA (submitted May 4, 2010) concluded that there are no unacceptable risks to higher trophic level receptors. The Final Problem Formulation has been updated accordingly.
15	The Problem Formulation background comparison (Section 2.2) appears to have failed to assess the data distributions for assigning appropriate statistical techniques for comparison. A 2-tailed T-test has been performed for all background comparisons, which only apply to normally distributed data sets. In addition, should the T-test be appropriate, a 1-tailed approach would add power to the test. It is possible that the results of this background comparison inappropriately conclude that site concentrations are equal to background concentrations, particularly if the data are not normally distributed. EPA background guidance requires such a distribution test, and the latest version of ProUCL (4.1) shall be used for this comparison in lieu of T-test applications from the web. Until appropriate statistical background comparisons are demonstrated, the statement "The conclusion is that Site concentration of these metals are not different from the background concentrations for all metals evaluated." (Paragraph 3) is not justified and shall be removed.	Although there are limitations to the t-test procedure, EPA's *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites* (2002; page A-7) concludes that the t-test is robust and has demonstrated good performance when the population distributions are not normal. The robustness of the t-test against non-normality is also a common theme in most statistics texts based on the Central Limit Theorem. While a myriad of statistical tests exist, application of the t-test to site and background data is not unreasonable, and is likely as reliable as any test for identifying whether the background and site data sets are significantly different. A review of the p-values resulting from the calculated t-tests indicates that the difference between one-tailed and two-tailed tests would generally not have a significant impact on the conclusions of the background comparisons.

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Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
16	No justification has been provided as to why a 2-tailed T-test is appropriate. An analysis shall be performed to determine the data distribution (i.e. normal, lognormal, or random) and the most appropriate statistical test. Consider using the Wilcoxon Rank Sum test for non-normal data, and using ProUCL Version 4.1 background software. A clear null hypothesis shall be provided in the text for the background tests.	See response to Comment #15. The Final Problem Formulation text has been modified to include the following: "The null hypothesis of the background comparison test is that the concentration in samples from potentially impacted areas is less than or equal to the mean concentration in background areas".
17	Regarding the Work Plan/SAP, the proposal for sampling locations for the toxicity testing for the BERA shall be based (and documented) on a rationale/strategy for collecting samples along a concentration gradient. Further samples are needed to capture the concentration gradient than just those from Figures in the SLERA displaying HQ exceedances of unity. The goal is, at the end of the BERA, is to determine ecologically-protective concentrations for contaminants for consideration in remedial decision-making. Thus, samples would shall to be collected from locations from the nature and extent of contamination document where there are not HQ exceedances to determine the NOAEL level. The intent is not to bias the sampling locations to only where the HQs exceeded unity and to where the greatest number of contaminants had HQs exceeding unity. To more associate the results of the toxicity test to a contaminant's (or similarly acting group of contaminants) concentrations at that location, it would be best if (to the extent possible) locations for toxicity testing were selected separating out PAHs from pesticides, and from metals, sampling each along the respective concentration gradient. Explanation shall be provided for what can be done to achieve this. The intention that shall be incorporated into Tables 4 and 5 of the Problem Formulation is to develop site-specific NOAELs and LOAELs. Before the Work Plan/SAP document is resubmitted, a teleconference is needed for agreement on proposed sampling locations with rationale by contaminant (or groups of contaminants). Regarding PAHs, dibenzo(a, h) anthracene would be a good	A sufficient number of locations are proposed to obtain a reasonable representation of Site conditions. As stated in the response to comment # 4, the Final BERA Work Plan/SAP incorporates moving the proposed sediment sample EWSED03 approximately 150 ft to the northwest (from RI/FS location NC4SE12 to NC3SE11) to allow evaluation of lower level concentrations of site COPECs.

Attachment A

Response to EPA and TCEQ April 14, 2010 Comments on Draft BERA Problem Formulation and Work Plan & Sampling and Analysis Plan

Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
	conservative protective indicator for selection of locations for sampling along a concentration gradient. Also, LPAH, HPAH, and TPAH groupings would be acceptable for selection of sample locations for the toxicity testing due to similarity in mechanism of toxic action.	
18	P. 10, last paragraph, Section 2.3 Spatial Distribution of Remaining COPECs: Acrolein shall be retained as a COPEC because it was detected in 25% of the samples. Acrolein shall also be included in the analyses of the surface water samples used to evaluate water toxicity via the mysid shrimp toxicity test.	Acrolein was retained as a COPEC in the Final Problem Formulation and Final BERA Work Plan/SAP for the Wetlands Surface Water. Acrolein is a volatile organic compound (VOC); the associated analytical method has been added to the Final BERA Work Plan/SAP for surface water in the wetland area.
19	Page 12, Section 3: Regarding the use of midpoints between ERLs and ERMs, mention and a brief summary shall be made of Long and MacDonald's 1998 article for interpretation of ERL and ERM data.	A brief discussion regarding the use of co-occurrence sediment quality guidelines such as ERLs and ERMs has been added to the Final Problem Formulation.
20	P. 12, 2nd paragraph, Section 3.0 Characterization of Ecological Effects: It is unclear why TCEQ was not used as a source for the ER-Ls and ER-Ms, especially since there appears to be errors in the referenced Table 3. Also see Table 3 comments. The TCEQ ER-L values shall be used.	The Final Problem Formulation and Final BERA Work Plan/SAP have been modified to reference TCEQ marine sediment benchmarks (e.g., ERLs) where available (otherwise sediment quality guidelines from Buchman [2008]).
21	Page 13 of the Problem Formulation, regarding potentially complete, but less significant exposure pathways language in the first paragraph as well as reflected in Figures 10 and 11: on Figure 10, the Note: (Significant Potential Receptors shown in bold) shall be changed to state that these are the remaining receptors for evaluation in the BERA after the Refinement of COPECs. Analogously, this footnote shall be changed for Figure 11 as well. Additionally, all fish receptors listed on the site conceptual site model shall be bolded as well (since there were surface water quality exceedances, which include fish in the aquatic biota to be protected; the Jarvinen and Ankley assessment was not the only assessment for fish, therefore, fish are not to be eliminated from the BERA).	The aquatic and terrestrial Conceptual Site Models (Figures 10 and 11 in the Final Problem Formulation, and Figures 3 and 4 in the Final BERA Work Plan/SAP) have been modified to note that "Bolded receptors are those remaining for evaluation in the BERA after Problem Formulation refinement." Additional symbols have been added to the four figures to note that there is no unacceptable risk to the upper trophic level receptors in the Final SLERA (submitted May 4, 2010). Also, fish receptors have been bolded on Figure 11 of the Final Problem Formulation and Figure 4 of the Final BERA Work Plan/SAP.

Attachment A

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Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
22	Toxicity profiles describing the mechanism of toxicity and the literature toxicity studies for the contaminants shall be added to the Problem Formulation document.	Environmental Fate/Transport and Toxicological Profiles have been added to the Final Problem Formulation for COPECs listed in Table 29 of the Final SLERA (submitted May 4, 2010).
23	Page 16 of the Problem Formulation, fourth sentence, last paragraph: the word "decreases" shall be substituted by the word "increases" given the logic on the number of substituted chlorines and ability to metabolize, thus, the sentence shall read "This class of compounds are soluble in lipids and partition readily into the fatty tissues of higher-level consumers, with the ability to be metabolized decreasing as the number of substituted chlorines increases. (not "decreases"). This is the needed correction because the next sentence states that "For highly substituted compounds, metabolism is less likely..."	The recommended edit has been incorporated in the Final Problem Formulation.
24	Page 17 of the Problem Formulation, end of first bullet: the word "northwest" shall be changed to the word "northeast".	The recommended edit has been incorporated in the Final Problem Formulation.
25	Page 21 of the Problem Formulation: fish shall be added to Risk Question #2. Explanation shall be provided that by conducting a mysid shrimp bioassay, fish would be covered as protected because the mysid shrimp would have greater exposure and be more sensitive; this holds true only if documentation can be provided that ammonia is not an issue from site-related sources that would necessitate the addition of the inland silverside fish toxicity test (as fish are more sensitive to ammonia than mysid shrimp).	There are no indications that ammonia was used as part of barge cleaning or other Site operations. Toxicity testing of fish is therefore not proposed. See response to Comment #2.
26	Table 3: The units are not specified in this table, although they are assumed to be mg/kg. The units shall be included. Also, it is unclear how the midpoint for 4,4'-DDT (0.032045 mg/kg) was determined as it does not correspond to the midpoint of the ER-L and ER-M (or any other values) presented in the SQUIRTS Table. In addition, TCEQ (2006) midpoint values for Sum DDT (0.00298 mg/kg) and Total DDT (0.02379 mg/kg) are both more conservative than the Table 3 value and shall be used. Similarly, it is unclear how the midpoint value for Total PAHs (11.86105	The units are mg/kg and have been included on Table 2 of the Final Problem Formulation. (Table 3 was deleted since the benchmarks are provided on the revised Table 2). The Final Problem Formulation and Final BERA Work Plan/SAP have been modified to reference TCEQ marine sediment benchmarks (e.g., ERLs) where available (otherwise sediment quality guidelines from Buchman [2008]).

Attachment A

Response to EPA and TCEQ April 14, 2010 Comments on Draft BERA Problem Formulation and Work Plan & Sampling and Analysis Plan

Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
	mg/kg) was derived as it does not correspond to the values in the SQUIRTS Tables. Finally, the "Notes" reference to "Buchman, 2009" is actually to "Buchman, 2008". Given these issues, the TCEQ values shall be used instead of the NOAAs SQUIRTS values.	
27	Section 5.3.1, page 30, and Section 5.3.2, page 31: project- or method-specific precision and accuracy criteria for the project have not been included, and shall be presented in these sections.	Precision and accuracy objectives have been added to the Final BERA Work Plan/SAP.
28	Tables G-1 and G-4 of the Problem Formulation: Lead shall be listed here as the HQ for the sandpiper exceeded 1 for pond sediment in the SLERA.	The Final SLERA (submitted May 4, 2010) concluded that there are no unacceptable risks to higher trophic level receptors. The Final Problem Formulation has been modified accordingly by removing Appendices C through H.
29	Table G-4 of the Problem Formulation: The zinc values in this table could not be corroborated. The zinc values shall be supported, or revised as appropriate.	The Final SLERA (submitted May 4, 2010) concluded that there are no unacceptable risks to higher trophic level receptors. The Final Problem Formulation has been modified accordingly by removing Appendices C through H.
30	Regarding the Work Plan/SAP, it is inappropriate to avoid collecting/analyzing soil samples and conducting soil toxicity tests based on a pending soil removal action that may or may not occur. This document shall present plans for collecting soil samples (including locations, numbers, depths, and analyses) to address any identified risk issues. Then, if the removal action does occur, modifications to this document can be made as needed.	Soil invertebrate toxicity testing is not proposed in the Final BERA Work Plan/SAP. See response to Comment # 3.
31	Regarding the Work Plan/SAP, more detailed language shall be included for the 7 steps of DQOs. For instance, regarding the toxicity tests, the testable hypotheses shall be stated in terms of a null hypothesis, and shall include p statement language regarding type 1 error (alpha, false positive value) a priori. This shall be stated in terms of a null hypothesis (i.e., probability of rejecting a null hypothesis when it is true).	Additional details regarding the Data Quality Objectives have been added to Section 3 of the Final BERA Work Plan/SAP.
32	Regarding the Work Plan/SAP, no defined DQOs result in the absence of clear directions as to how the collected data will be	Additional details regarding the Data Quality Objectives have

Comment No.	Comment	Response
	interpreted and applied to determine ecologically-protective concentrations of contaminants (based on back-calculations of site-specific, contaminant-specific NOAEL and LOAEL ecotoxicity values) for recommendation in consideration for remedial risk management decision-making. This information shall be included to enable understanding for how PRGs will be determined at the end of the BERA. For example, toxicity tests can; along with other lines of evidence, assist in the determination of whether the matrix is toxic. Apparent effects in toxicity tests will not tell one exactly which chemical is causing the toxicity, but these data, used with other lines of evidence (such as dry sediment concentrations exceeding probable effect concentrations) can assist in determining which particular chemical(s) are responsible for the toxicity. The document shall be revised to include a discussion of how chemical analytical and bioassay results will be used in making risk management decisions and setting remedial objectives. This shall be included in the updated DQO section, particularly in the "if-then" series of project decisions. A first step would be discussion of how the weight of evidence will be used to determine whether risks require further consideration in risk management. The text shall then discuss how risk results would be used to set remedial action objectives. Finally, text shall be added to discuss how data can be used to define remedial action levels. Standard methods include but are not limited to: a. Creating a regression relating chemistry to bioassay results and selecting chemical concentrations as clean-up goals based on an expected level of impact; b. Creating effects and no effects ranges of concentrations based on bioassay results and using these to establish effects thresholds; and c. Using bioavailability data to modify literature-based benchmarks, and evaluating relevance based on relationships to bioassay results.	been added to Section 3 of the Final BERA Work Plan/SAP.

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Comment No.	Comment	Response
33	P. 12, Section 3.2 Study Design, last paragraph: As previously stated, soil samples shall be initially included in the study design and then dropped if the results of the pending removal action indicate it is appropriate to do so.	Soil sampling and invertebrate toxicity testing are not proposed in the Final BERA Work Plan/SAP. See response to Comment #3.
34	P. 12-14, Section 3.3 Analytical Methods: Discussions of the earthworm toxicity test and soil analyses shall be included in this section and then vacated if the results of the pending removal action indicate it is appropriate to do so.	Soil sampling and invertebrate toxicity testing are not proposed in the Final BERA Work Plan/SAP. See response to Comment #3.
35	P. 13, Sediment chemical analysis, Section 3.3 Analytical Methods: Field measurements of redox potential shall be included in these analyses. Accurate evaluation of the actual in situ concentrations of AVS/SEM requires sampling, handling, and analysis techniques that will maintain the in situ redox conditions. Also see additional comments on AVS/SEM.	The Final BERA Work Plan/SAP has been modified to reflect that field measurement of the redox potential (Eh) of sediments will be measured with a portable pH/Eh meter.
36	Section 5.3, page 30, last paragraph of the Work Plan/SAP: the text states "Based on the results of the Problem Formulation... quality of data and acceptable levels of decision error were established as presented in Section 3.0." Section 3.0 did not present the quality or acceptable levels of decision error. This information shall be added to the text.	Precision and accuracy have been addressed in the Final BERA Work Plan/SAP.
37	P. 14, Sediment physical properties, Section 3.3 Analytical Methods: The statement about the findings from the pending RI/FS regarding "...consistent sediment grain size distribution throughout the investigation area" is acknowledged. However, it is believed that some degree of -variability of sediment grain size between areas and within samples from the same area will occur. This variability is particularly important in the interpretation of AVS/SEM results. Therefore, grain size analysis shall be included for the AVS/SEM samples at a minimum.	The Final BERA Work Plan/SAP has been modified to include grain size analysis for all of the AVS/SEM sample locations.
38	For each of the toxicity test samples, particle or grain size	The Final BERA Work Plan/SAP has been modified to include

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Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
	analysis shall be conducted concurrently and collocated with the samples (this is especially important regarding bioavailabity of PAHs with respect to toxicity because of PAH adsorption) (see also page 15 of the Problem Formulation). The analogy applies to the TOC measurements to be matched to the toxicity test samples for more definitive decision-making.	grain size analysis for all of the AVS/SEM sample locations. The Final BERA Work Plan/SAP includes TOC analysis at all sediment sample locations.
39	Concurrent and co-located sampling for redox potential shall be proposed. Additionally, these shall be dedicated samples (collocated, but not aliquots, as well as concurrent) separate from the sample for AVS/SEM measurements, the toxicity testing, and analytical sampling so that there is no disturbance affecting measurement of the redox potential. Likewise, a dedicated (co-located, but not aliquot, as well as concurrent) toxicity test sample separate from the media sample for chemical analysis shall be collected.	As proposed in the response to comment #35, the Final BERA Work Plan/SAP has been modified to reflect that field measurement of the redox potential (Eh) of sediments will be measured with a portable pH/Eh meter. Field observations will also be documented, including the sediment texture and consistency; color; presence of biota or debris; and changes in sediment characteristics with depth.
40	Page 7 of the Work Plan/SAP, Assessment Endpoints, second sentence: the word "relevant" shall be substituted with the word "sensitive and susceptible".	The recommended edit has been incorporated in the Final BERA Work Plan/SAP.
41	Field measurements of water quality parameters (e.g. salinity, DO, temperature, etc.) are not discussed in the Work Plan/SAP text. Field measurements of these parameters at sediment and surface water locations shall be included.	The Final BERA Work Plan/SAP has been modified to include field measurements of the following water quality parameters (at all surface water and sediment sampling locations): pH, conductivity, temperature, salinity, and dissolved oxygen.
42	Page 10 of the Work Plan/SAP, last bullet: the word "sediment" shall be changed to "media".	The recommended edit has been incorporated in the Final BERA Work Plan/SAP.
43	Page 11 of the Work Plan/SAP, Study Design: soil invertebrate toxicity testing shall be added. A description shall be included for how these lines of evidence will be used to develop ecologically-protective PRGs for consideration in remedial decision-making. Additionally, it shall be mentioned that the toxicity testing results will be used to develop site-specific LOAELs and NOAELs.	Soil invertebrate toxicity testing is not proposed in the Final BERA Work Plan/SAP. See response to Comment # 3.
44	Section 3.1, 2nd paragraph, page 11 and Section 5.3, page 29: reference is made to USEPA DQO process, and refers to EPA	The recommended edit has been incorporated in the Final

Attachment A

Response to EPA and TCEQ April 14, 2010 Comments on Draft BERA Problem Formulation and Work Plan & Sampling and Analysis Plan

Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
	(2000). EPA (2000) was updated in EPA (2006), and there were some changes to the names of the process. The DQO statements shall reflect the revised guidance.	BERA Work Plan/SAP.
45	Page 12, Page. 14, Section 3.4 Station Locations and Rationale, Page 19-20 Section 4.2 Sampling Locations, Timing, and Frequency, and Table 3 of the Work Plan/SAP: in the first complete paragraph, it is stated that "Sample station locations have been selected based on the number and magnitude of COPECs with HQs >1 as shown on Table 3" (See also page 14 of the Work Plan/SAP, Section 3.4): Although some samples should be collected in areas where previous samples have indicated the presence of high COPEC concentrations and or multiple COPECs, it is not appropriate that all samples meet these criteria. Particularly for samples that are to be submitted for toxicity testing, it is important that the samples not all be purposefully biased high in order to allow for a more meaningful interpretation of the results. Rather, the sample station locations shall be selected based on concentration gradients for each of the COPECs which would include stations with concentrations reflecting HQs both above and below unity as mentioned in a comment above. Thus, more samples shall be included than those proposed on the Figures, and the detailed rationale provided.	A sufficient number of locations are proposed to obtain a reasonable representation of site conditions. As stated in the response to comment # 4, the Final BERA Work Plan/SAP incorporates moving the proposed sediment sample EWSED03 approximately 150 ft to the northwest (from RI/FS location NC4SE12 to NC3SE11) to allow evaluation of lower level concentrations of site COPECs.
46	Regarding the Work Plan/SAP, there shall be further explanation that depths for collection of the samples for toxicity tests shall be matched with the samples for analytical media sampling as well as for samples to be used for estimating measures of bioavailability. These samples shall not be aliquots so as to not cause a disturbance of the sample resulting in any loss of COPECs.	The Final BERA Work Plan/SAP has been modified to clarify that the sample collection depth for toxicity tests will be matched with the sample depth for COPEC, AVS/SEM, TOC, and grain size analysis. Figure 7 of the Final BERA Work Plan/SAP lists the depths of the original samples. The majority of these samples are within the top 6 inches of sediment.
47	Because polychaetes burrow, the depth of the sampling for the polychaete Neanthes toxicity test shall be matched to an appropriate depth for this polychaete, and the rationale provided. See also page 18 (Field Sampling Plan). Acceptance	Figure 7 of the Final BERA Work Plan/SAP lists the depths of the original samples. The majority of these samples are within the top 6 inches of sediment. Laboratory quality control checks and acceptance criteria are provided in Section 12.0 of the

Attachment A

Response to EPA and TCEQ April 14, 2010 Comments on Draft BERA Problem Formulation and Work Plan & Sampling and Analysis Plan

Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
	criteria shall be provided for the Neanthes toxicity test.	Neanthes SOP (see Appendix B of the Final BERA Work Plan/SAP).
48	Page 12 of the Work Plan/SAP, second complete paragraph: the last sentence ("COPECs 4,4-DDT and Aroclor-1254, and the soil exposure pathway in this area were carried forward from the problem formulation; however, based on the pending Removal Action, soil samples are not included in the ecological investigation study design") shall be eliminated and replaced with a sentence stating that soil samples are included in the ecological investigation study design for this area.	Soil sampling and invertebrate toxicity testing are not proposed in the Final BERA Work Plan/SAP. See response to Comment #3.
49	Page 13 of the Work Plan/SAP, second complete paragraph: where the mysid shrimp toxicity test is mentioned, it shall be added that this test receptor was selected as more susceptible to exposure to COPECs than fish, and that therefore, assessing for this receptor would include protectiveness for fish as well; this language shall only be added pending documentation that ammonia is not an issue necessitating the inclusion of an inland silverside fish toxicity test.	The recommended edit has been incorporated in the Final BERA Work Plan/SAP. See response to comment #2.
50	Total Organic Carbon will assist in the estimation of the bioavailability of non-polar organics such as DDT and shall be assessed.	The Final BERA Work Plan/SAP includes TOC analysis at all sediment sample locations.
51	Page 14 of the Work Plan/SAP, second complete paragraph: particle size shall be collected with each of the samples collected for the toxicity testing. Also, collection of soil analytical data concurrent and co-located with the soil invertebrate toxicity testing shall be added to the plan.	The Final BERA Work Plan/SAP has been modified to include grain size analysis for all of the wetland sediment AVS/SEM sample locations. See response to comments #37. Soil sampling and invertebrate toxicity testing are not proposed in the Final BERA Work Plan/SAP. See response to Comment #3.
52	Section 3.3 of the Work Plan/SAP, Surface water analyses, page 14: this section states method 6010/6020 will be used to assess dissolved copper. Because the water is saline, it is likely that there will be elevated method detection and reporting limits because of sample dilution. A discussion/assessment shall be	The proposed analytical laboratory (Columbia Analytical Services) method detection limit for copper in saline water is approximately two orders of magnitude below the TSWQS (see Table 6 of the Final BERA Work Plan/SAP).

Attachment A

Response to EPA and TCEQ April 14, 2010 Comments on Draft BERA Problem Formulation and Work Plan & Sampling and Analysis Plan

Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
	provided to determine if either of these methods will achieve the detection limit required for surface water risk values.	
53	Page 14 of the Work Plan/SAP, Section 3.4: regarding the third sentence ("Sediment sampling locations in the wetland area were selected to focus on locations where the HQ was greater than 3"), "3" shall be changed to "1", and the resultant changes shall be described in the sampling locations and numbers to facilitate better interpretation of toxicity test results. Sediment sample locations from the wetlands area should not all focus on locations where the HQ > 3, especially since no data interpretation (Section 3.5) is provided for the scenario where the sample is toxic and the HQ is less than 3 but greater than 1.	Proposed sediment sampling locations in the Final BERA Work Plan/SAP are based on the results of the Final Problem Formulation, and represent a cross section of target COPECs across the wetland area. While sediment sampling locations in the wetland area are focused on specific locations where one or more HQs exceed 3, the same locations also represent a range of screening results. A sufficient number of locations are proposed to obtain a reasonable representation of site conditions. As stated in the response to comment # 4, the Final BERA Work Plan/SAP incorporates moving the proposed sediment sample EWSED03 approximately 150 ft to the northwest (from RI/FS location NC4SE12 to NC3SE11) to allow evaluation of lower level concentrations of site COPECs.
54	Page 14 of the Work Plan/SAP, Section 3.4: regarding the last sentence ("Areas of the Site that will be covered by the pending Removal Action to repair the former surface impoundments cap, including the area immediately south of the former surface impoundments, are not proposed for sampling") shall be removed, and those areas shall be proposed for earthworm toxicity testing. All statements regarding areas not proposed for sampling based on the pending removal action should be deleted and these areas should be included for sampling.	Soil sampling and invertebrate toxicity testing are not proposed in the Final BERA Work Plan/SAP. See response to Comment #3.
55	Page 15 of the Work Plan/SAP, Data Interpretation Procedure: in this section, more detail shall be included as generally commented above regarding a DQO decision rule, null hypothesis, and Type I error, p value statements.	The data interpretation procedure in Section 3 of the Final BERA Work Plan/SAP has been expanded.
56	Section 3.5, page 15 of the Work Plan/SAP: this section states that a line-of-evidence approach will be used. Additional discussion shall be included regarding both the individual lines of evidence and the overall weight of evidence evaluation. For lines of evidence, the following additional information shall be included:	The data interpretation procedure in Section 3 of the Final BERA Work Plan/SAP has been expanded to address this comment.

Attachment A

Response to EPA and TCEQ April 14, 2010 Comments on Draft BERA Problem Formulation and Work Plan & Sampling and Analysis Plan

Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
	a. test endpoints (as listed later on page 26) and their relevance; b. details regarding comparisons, including whether they will be conducted quantitatively or qualitatively; whether they will be conducted on a location-by-location basis or using group statistics; the type of statistics planned; and the planned interpretation of comparisons to both reference and control samples; c. details regarding trend analyses, including whether they will be conducted quantitatively or qualitatively; the type of statistics planned; source-related parameters (i.e. sediment and pore water COPEC concentrations, AVS/SEM results, etc.) to be evaluated for influence on bioassays; and non-source related parameters to be evaluated for influence on bioassays (i.e. ammonia, grain size, salinity etc.), and; d. discussion of rationale and methods for any other types of evaluation planned. The section shall also include a discussion of the overall weight of evidence approach. Discussion of a qualitative weight of evidence approach typically includes a description of the relative reliability, relevance, and importance of each line of evidence and explains the general process by which conclusions will be reached.	
57	Page 19 of the Work Plan/SAP, Surface Water Sampling: it is stated that surface water samples will be collected from one location north of the wetlands north of Marlin Avenue. Collection of only one sample is inadequate, and sampling along a concentration gradient shall be performed.	An additional surface water sample location (EWSW03) has been added to the Final BERA Work Plan/SAP (see Table 2 and Figure 8).
58	P. 17-19, Section 4.1.1 Sediment Sampling: It is unclear from the discussion, but dedicated AVS/SEM samples shall be collected and not be an aliquot of a larger sample. In addition, the depth of the AVS/SEM samples shall be consistent as AVS will vary with depth.	The Final BERA Work Plan/SAP has been modified to clarify that dedicated AVS/SEM samples will be sampled separately and that the depth of the AVS/SEM samples will be consistent with the other co-located samples.

Attachment A

Response to EPA and TCEQ April 14, 2010 Comments on Draft BERA Problem Formulation and Work Plan & Sampling and Analysis Plan

Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
59	P. 18, Intracoastal Waterway Sediment, last paragraph: Care shall be taken to avoid pouring off any fine sediment when draining the overlying water from the sampler.	The recommended edit has been incorporated in the Final BERA Work Plan/SAP.
60	Section 4.1.2 of the Work Plan/SAP, Pore Water Sampling, page 19: the third sentence mixes units (ft and cm), and the rest of the section uses units of ft and in. Consistency in units shall be maintained.	Section 4.1.2 of the Final BERA Work Plan/SAP has been edited so that the units are consistent.
61	Section 4.2 of the Work Plan/SAP, page. 19: the work plan does not include a schedule for performing the samples collection, analysis, and validation. A schedule shall be added to the work plan such that all sample collection, analysis, and validation actions shall be completed no later than sixty (60) calendar days following receipt of EPA approval of the Work Plan/SAP.	The Final BERA Work Plan/SAP proposes ninety (90) calendar days for sample collection, analysis, and data validation following receipt of EPA approval of the Final BERA Work Plan/SAP. This schedule consists of the following sequential activities: 1-2 weeks to organize the field effort; 2-3 weeks for sample collection; 6 weeks for laboratory analyses (including 28-day toxicity tests); and 3 weeks for data validation.
62	P. 25-26, Section 4.6.3 Toxicity Testing Methods and Tables 2 through 5: As previously stated, the earthworm toxicity test and soil samples shall be included.	Invertebrate toxicity testing is not proposed in the Final BERA Work Plan/SAP. See response to Comment # 3.
63	Section 5.3 of the Work Plan/SAP, Data Quality Objectives, page 29: there is no "sensitivity" DQO established within this section of the document. The sensitivity DQO shall be included.	This sensitivity DQO has been incorporated as Section 5.3.6.
64	Section 5.3.1 of the Work Plan/SAP, Precision, page 30 and Section 5.3.2, Accuracy, page 31: project- or method-specific precision and accuracy criteria for the project have not been presented in these sections. Precision and accuracy criteria shall be included.	Precision and accuracy criteria have been incorporated into the Final BERA Work Plan/SAP.
65	Section 5.3.3 of the Work Plan/SAP, Completeness, page 31: a completeness goal on the sample level of 90% has been established. There are several critical samples (such as surface water dissolved copper) that would suggest that a completeness goal of 100%, for those samples would be appropriate. A completeness goal of 100% shall be established for these samples.	The Final BERA Work Plan/SAP sets a completeness goal of 95% for aqueous samples. Invalidation of any of the proposed surface water sample results would result in further evaluation based upon the reason for rejection.

Attachment A

Response to EPA and TCEQ April 14, 2010 Comments on Draft BERA Problem Formulation and Work Plan & Sampling and Analysis Plan

Gulfco Marine Maintenance Superfund Site

Freeport, Brazoria County, Texas

Comment No.	Comment	Response
66	Section 5.4.2 of the Work Plan/SAP, Sampling Quality Control Requirements and Acceptability Criteria, page 33: acceptability criteria have not been established in this section; acceptability criteria shall be included.	Section 5.4.2 of the Final BERA Work Plan/SAP has been updated to include acceptability criteria.
67	Table 2 of the Work Plan/SAP, Analytical Methods: this table is not referenced in the text; a reference shall be added in the text at the appropriate location.	Reference to table 4 (formerly table 2) has been added to the Final Work Plan/SAP section 4.6.2.
68	Tables 1-5: These tables shall be modified to reflect the inclusion of soil samples and the earthworm toxicity test, as appropriate	See response to Comment # 3. Soil sampling and invertebrate toxicity testing are not proposed in the Final BERA Work Plan/SAP.

References:

Buchman, M.F., 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.

Long, E.R., and D.D. MacDonald. 1998. Recommended uses of empirically derived sediment quality guidelines for marine and estuarine systems. Human and Ecological Risk Assessment. 4(5): 1019-1039

TCEQ. 2006. Update to Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas RG-263 (Revised).January 2006 Version. http://www.tceq.state.tx.us/remediation/eco/eco.html

U.S. EPA. 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Peer Review Draft. Office of Solid Waste and Emergency Response. EPA 530-D-99-001A, August.
http://www.epa.gov/earthlr6/6pd/rcra c/protocol/slerap.htm

U.S. EPA 2002. Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Site. Office of Emergency and Remedial Response, EPA 540-R-01-003, September.

U.S. 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process. Office of Environmental Information. EPA QA/G-4. February.

ATTACHMENT B

REDLINE/STRIKEOUT OF FINAL BASELINE ECOLOGICAL RISK ASSESSMENT PROBLEM FORMULATION TEXT RELATIVE TO TEXT OF MARCH 10, 2010 DRAFT

FINAL BASELINE ECOLOGICAL RISK ASSESSMENT
PROBLEM FORMULATION

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FOR THE
GULFCO MARINE MAINTENANCE
SUPERFUND SITE
FREEPORT, TEXAS

PREPARED BY:

URS Corporation
10550 Richmond Avenue, Suite 155
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MAY 10, 2010

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MARCH

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TABLE OF CONTENTS

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LIST OF TABLES

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LIST OF FIGURES

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LIST OF APPENDICES

Appendix	Title
A	Table 29 (COPECs and Media Recommended for Further Evaluation in the Baseline Ecological Risk Assessment) from SLERA
B	Background Comparisons
C	Environmental Fate/Transport and Toxicological Profiles

Deleted: C . Ecological Hazard Quotient Calculations for South Area Soil¶
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D . Ecological Hazard Quotient Calculations for North Area Soil¶
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E . Ecological Hazard Quotient Calculations for Intracoastal Waterway Sediment¶
¶
F . Ecological Hazard Quotient Calculations for Wetland Sediment¶
¶
G . Ecological Hazard Quotient Calculations for Pond Sediment¶
¶
H . References for the Appendices¶

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LIST OF ACRONYMS

AET – apparent effects threshold

AST – aboveground storage tank

AUF – area-use factor (unitless)

BERA – Baseline Ecological Risk Assessment

COPEC – contaminants of potential ecological concern

CSM – conceptual site model

DDD – dichlorodiphenyldichloroethylene

DDE – dichlorodiphenyldichloroethane

DDT – dichlorodiphenyltrichloroethane

EPA – United States Environmental Protection Agency

ERL – effects range low

GRG – Gulfco Remediation Group

Deleted: ERM – effects range medium¶

HPAH – high-molecular weight polynuclear aromatic hydrocarbon

HQ – hazard quotient

LPAH – low-molecular weight polynuclear aromatic hydrocarbon

Deleted: LOAEL – lowest-observed-effects-level¶

NEDR – Nature and Extent Data Report

NOAEL – no-observed-adverse-effects-level

NPL – National Priorities List

PAH – polynuclear aromatic hydrocarbon

PCB – polychlorinated biphenyl

PSA – Potential Source Area

Deleted: PCL – Protective Concentration Level¶

RI/FS – Remedial Investigation/Feasibility Study

Deleted: QAPP – Quality Assurance Project Plan¶

SAP – Sampling and Analysis Plan

Deleted: ROPC – receptors of potential concern¶

SLERA – Screening-Level Ecological Risk Assessment

SMDP – Scientific Management Decision Point

SOW – Statement of Work

TCEQ – Texas Commission on Environmental Quality

TSWQS – Texas Surface Water Quality Standard

UAO – Unilateral Administrative Order

USFWS – United States Fish and Wildlife Service

WP/SAP – Work Plan and Sampling and Analysis Plan

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EXECUTIVE SUMMARY

The purpose of the Baseline Ecological Risk Assessment (BERA) problem formulation for the former Gulfco Marine Maintenance, Inc. site in Freeport, Brazoria County, Texas (the Site) is to use the Screening-Level Ecological Risk Assessment (SLERA) results and additional site-specific information to determine the scope and goals of the BERA.

Problem formulation includes the following:

- Refining the preliminary list of Contaminants of Potential Ecological Concern (COPECs) identified in the SLERA;
- Further characterizing the ecological effects of the refined COPEC list;
- Reviewing and refining information on contaminant fate and transport, complete exposure pathways, and ecosystems potentially at risk;
- Determining assessment endpoints (i.e., the specific ecological values to be protected); and
- Developing a conceptual site model with risk questions for the ecological investigation to address.

Steps were taken to refine the COPEC list (i.e., modification of conservative exposure assumptions, consideration of background metals concentrations, and review of spatial COPEC distributions) and conduct literature research on the ecological effects of the refined list of COPECs, as well as their fate and transport characteristics relative to Site conditions. Subsequent to these steps, the following ecosystems have been identified as potentially at risk:

- Localized wetland areas in the North Area of the Site and north of the Site. The primary COPECs with hazard quotients (HQs) greater than one in wetland sediment are several polynuclear aromatic hydrocarbons (PAHs). Most of the PAH HQs exceedances are located in three areas: (1) a small area immediately northeast of the former surface impoundments; (2) a smaller area immediately south of the former surface impoundments; and (3) at a sample location in the southwest part of the North Area approximately 60 feet north of Marlin Avenue. Additionally, total acrolein and dissolved copper in wetland surface water in the first area (the area northeast of the former surface impoundments) exceed their respective ecological screening benchmark and Texas Surface Water Quality Standard (TSWQS).

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- Localized areas of Intracoastal Waterway sediment within former Site barge slips. The predominant COPECs in these areas, as reflected by HQ exceedances, are also PAHs. The total PAH concentration was highest in the northernmost sample in the western barge slip. In the eastern barge slip, exceedances were limited to three PAHs, hexachlorobenzene, and the sum of high molecular weight PAHs (HPAHs) in one sample.

- Localized area of North Area soils south of the former surface impoundments. The COPECs in this area, where some buried debris was encountered in the shallow subsurface, are 4,4'-DDT and Aroclor-1254.

The risk questions developed for these areas through the BERA Problem Formulation are:

Barge Slip and Wetland sediments: Does exposure to COPECs in sediment adversely affect the abundance, diversity, productivity, and function of sediment invertebrates?

Wetland surface water: Does exposure to COPECs in surface water adversely affect the abundance, diversity, productivity, and function of water-column invertebrates and fish?

North Area soils: Does exposure to COPECs in soil adversely affect the abundance, diversity, productivity, and function of soil invertebrates?

The approach for evaluating these risk questions, through the development and implementation of testable hypotheses and measures of effect and exposure based on this BERA problem formulation, will be described in the BERA Work Plan and Sampling and Analysis Plan (SAP).

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1.0 INTRODUCTION

The United States Environmental Protection Agency (EPA) named the former site of Gulfco Marine Maintenance, Inc. in Freeport, Brazoria County, Texas (the Site) to the National Priorities List (NPL) in May 2003. The EPA issued a modified Unilateral Administrative Order (UAO), effective July 29, 2005, which was subsequently amended effective January 31, 2008. The UAO required Respondents to conduct a Remedial Investigation and Feasibility Study (RI/FS) for the Site. Pursuant to Paragraph 37(d)(x) of the Statement of Work (SOW) for the RI/FS, included as an Attachment to the UAO, a Final Screening Level Ecological Risk Assessment (SLERA) was prepared by Pastor, Behling & Wheeler, LLC (PBW), on behalf of LDL Coastal Limited LP (LDL), Chromalloy American Corporation (Chromalloy) and The Dow Chemical Company (Dow), collectively known as the Gulfco Restoration Group (GRG) (PBW, 2010a). The Scientific/Management Decision Point (SMDP) provided in the Final SLERA concluded that the information presented therein indicated a potential for adverse ecological effects, and a more thorough assessment was warranted. A Draft Baseline Ecological Risk Assessment (BERA) Problem Formulation was prepared by PBW, consistent with Paragraphs 37(d)(xi) and (xii) of the UAO as the next step in that assessment (PBW, 2010b). This Final BERA Problem Formulation report has been prepared by URS Corporation (URS) based on comments received from the EPA and Texas Commission on Environmental Quality (TCEQ).

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Figure 1 provides a map of the Site vicinity, while Figure 2 provides a Site map.

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1.1 REPORT PURPOSE

The ecological risk assessment process is outlined in the SOW (Page 20, Paragraphs 37(d)(xi) and (xii)). A diagram of the process as provided in EPA's Ecological Risk Assessment Process for Superfund (EPA, 1997) is provided in Figure 3. Problem formulation represents the third step in the eight-step ecological risk assessment process. The purpose of the problem-formulation phase is to refine the screening level problem formulation, and use the SLERA results and additional site-specific information to determine the scope and goals of the BERA.

As described in EPA, 1997, problem formulation includes the following:

- Refining the preliminary list of COPECs identified in the SLERA;
- Further characterizing the ecological effects of the refined COPEC list;

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- Reviewing and refining information on contaminant fate and transport, complete exposure pathways, and ecosystems potentially at risk;
- Determining specific assessment endpoints (i.e., the specific ecological values to be protected); and
- Developing a conceptual model with risk questions that the ecological investigation will address.

The SMDP at the end of problem formulation is the identification and agreement on the conceptual model, including assessment endpoints, exposure pathways, and questions or risk hypotheses. The results of this SMDP are then used to select measurement endpoints for development of the BERA Work Plan and Sampling & Analysis Plan (Work Plan/SAP).
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1.2 SITE BACKGROUND

1.2.1 Site Description

The Site is located in Freeport, Texas at 906 Marlin Avenue (also referred to as County Road 756) (Figure 1). The Site consists of approximately 40 acres along the north bank of the Intracoastal Waterway between Oyster Creek (approximately one mile to the east) and the Texas Highway 332 bridge (approximately one mile to the west). The Site includes approximately 1,200 feet (ft.) of shoreline on the Intracoastal Waterway, the third busiest shipping canal in the US (TxDOT, 2001) that, on the Texas Gulf Coast, extends 423 miles from Port Isabel to West Orange.

Marlin Avenue divides the Site into two primary areas (Figure 2). For the purposes of descriptions in this report, Marlin Avenue is approximated to run due west to east. The property to the north of Marlin Avenue (the North Area) consists of undeveloped land and closed surface impoundments, while the property south of Marlin Avenue (the South Area) was developed for industrial uses with multiple structures, a dry dock, sand blasting areas, an aboveground storage tank (AST) tank farm, and two barge slips connected to the Intracoastal Waterway. The South Area is zoned as "W-3, Waterfront Heavy" by the City of Freeport. This designation provides for commercial and industrial land use, primarily port, harbor, or marine-related activities. The North Area is zoned as "M-2, Heavy Manufacturing."

Adjacent property to the north, west, and east of the North Area is undeveloped. Adjacent property to the east of the South Area is currently used for industrial purposes while to the west
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the property is currently vacant and previously served as a commercial marina. The Intracoastal Waterway bounds the Site to the south. Residential areas are located south of Marlin Avenue, approximately 300 feet west of the Site, and 1,000 feet east of the Site.

The Intracoastal Waterway is a major corridor for commercial barge traffic and other boating activities. Approximately 50,000 commercial vessel trips and 28 million short tons of cargo were transported on the Galveston to Corpus Christi section of the Intracoastal Waterway in 2006. The vast majority of this cargo (greater than 23 million tons) was petroleum, chemicals or related products (USACE, 2006). The Intracoastal Waterway design width and depth in the vicinity of the Site, based on USACE mean low tide datum, is 125 feet wide and 12 feet deep (USACE, 2008). The waterway is maintained by periodic dredging operations conducted by the USACE as frequently as every 20 to 38 months, and as infrequently as every 5 to 46 years (Teeter et al., 2002). A September 2008 survey indicated that actual channel depths in the 19-mile reach from Chocolate Bayou to Freeport Harbor, which includes the Site vicinity, ranged from 9.3 to 11.1 feet (USACE, 2008). According to the USACE (USACE, 2009), the Intracoastal Waterway in the immediate vicinity of the Site is not currently scheduled for dredging, although dredging is performed approximately every three to four years and the area to the west near Freeport Harbor (Intracoastal Waterway Mile 395) was dredged in 2009.

The South Area includes approximately 20 acres of upland that was created from dredged material from the Intracoastal Waterway. The two most significant surface features within the South Area are a Former Dry Dock and the AST Tank Farm (Figure 2). The remainder of the South Area surface consists primarily of former concrete laydown areas, concrete slabs from former Site buildings, gravel roadways and sparsely vegetated open areas with some localized areas of denser brush vegetation, particularly near the southeast corner of the South Area.

Some of the North Area is upland created from dredge spoil, but most of this area is considered wetlands, as per the United States Fish and Wildlife Service (USFWS) Wetlands Inventory Map (Figure 4) (USFWS, 2008). This wetland area generally extends from East Union Bayou to the southwest, to the Freeport Levee to the north, to Oyster Creek to the east (see Figure 1). The most significant surface features in the North Area are two ponds (the Fresh Water Pond and the Small Pond) and the closed former surface impoundments. The former surface impoundments and the former parking area south of the impoundments and Marlin Avenue comprise the vast majority of the upland area within the North Area (Figure 4).

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Field observations during the RI indicate that the North Area wetlands are irregularly flooded with nearly all of the wetland area inundated by surface water that can accumulate to a depth of one foot or more during extreme high tide conditions, storm surge events, and/or in conjunction with surface flooding of Oyster Creek northeast of the Site (Figure 1). Due to a very low topographic slope and low permeability surface sediments, the wetlands are also very poorly draining and can retain surface water for prolonged periods after major rainfall events. Under normal tide conditions and during periods of normal or below normal rainfall, standing water within the wetlands (outside of the two ponds discussed below) is typically limited to a small, irregularly shaped area immediately north of the Fresh Water Pond and a similar area immediately south of the former surface impoundments (see Figure 2). Both of these areas can be completely dry, as was observed in June 2008. As such, given the absence of any appreciable areas of perennial standing water, the wetlands are effectively hydrologically isolated from Oyster Creek, except during intermittent, and typically brief, flooding events.

The Fresh Water Pond is approximately 4 to 4.5 feet deep and is relatively brackish (specific conductance of approximately 40,000 umhos/cm and salinity of approximately 25 parts per thousand). This pond appears to be a borrow pit created by the excavation of soil and sediment as suggested by the well-defined pond boundaries and relatively stable water levels. Water levels in the Fresh Water Pond are not influenced by periodic extreme tidal fluctuations as the pond dikes preclude tidal floodwaters in the wetlands from entering the pond, except for extreme storm surge events, such as observed during Hurricane Ike in September 2008.

The Small Pond is a very shallow depression located in the eastern corner of the North Area. The Small Pond is not influenced by daily tidal fluctuations and behaves in a manner consistent with the surrounding wetland, i.e., becomes dry during dry weather, but retains water in response to and following rainfall and extreme tidal events. Relative to the Fresh Water Pond, water in the Small Pond is less brackish based on specific conductance (approximately 14,000 umhos/cm) and salinity (approximately eight parts per thousand) measurements.

1.2.2 Site History

A detailed discussion of Site operational history was provided in the RI/FS Work Plan (PBW, 2006). Key elements of that discussion are noted herein. During the 1960s, the Site was used for

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occasional welding but there were no on-site structures (Losack, 2005). According to the Hazard Ranking Score Documentation (TNRCC, 2002), from 1971 through 1999, at least three different owners used the Site as a barge cleaning facility. Beginning in approximately 1971, barges were brought to the facility and cleaned of waste oils, caustics and organic chemicals, with these products stored in on-site tanks and later sold (TNRCC, 2002). Sandblasting and other barge repair/refurbishing activities also occurred on the Site. At times during the operation, wash waters were stored either on a floating barge, in on-site storage tanks, and/or in surface impoundments on Lot 56 of the Site. The surface impoundments were closed under the Texas Water Commission's (Texas Commission on Environmental Quality (TCEQ) predecessor agency) direction in 1982 (Carden, 1982).

Aerial spraying of the wetland areas north of Marlin Avenue, including the North Area, for mosquito control has historically been and continues to be performed by the Brazoria County Mosquito Control District and its predecessor agency, the Brazoria County Mosquito Control Department (both referred to hereafter as BCMCD). Aerial spraying for mosquito control has been performed over rural areas in the county since 1957 (Lake Jackson News, 1957). Historically, aerial spraying of a DDT solution in a "clinging light oil base" was performed from altitudes of 50 to 100 feet (Lake Jackson News, 1957). Recently BCMCD has been using Dibrom®, an organophosphate insecticide, with a diesel fuel carrier through a fogging atomizer application (Facts, 2006, 2008a, 2008b). Truck-based spraying has also been performed along Marlin Avenue. Both types of spraying were observed during the performance of Site RI activities.

1.3 REPORT ORGANIZATION

The organization for this report has been patterned after that suggested in EPA guidance (EPA, 1997). As such, Section 2.0 provides a refinement of the COPECs indentified in the SLERA. Section 3.0 characterizes the potential ecological effects of that refined list of COPECs. Section 4.0 describes significant fate and transport characteristics, ecosystems potentially at risk and complete exposure pathways. Section 5.0 describes assessment endpoints, and Section 6.0 provides the refined Conceptual Site Model and resulting risk decisions. The problem formulation SMDP is discussed in Section 7.0. Appendix A contains a table from the SLERA listing COPECs and media recommended for further evaluation in the BERA. Appendix B details a comparison of Site data to background. Appendix C presents environmental

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fate/transport and toxicological profiles for the COPECs identified in Table 29 of the Final 2010 SLERA (PBW, 2010a).

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2.0 REFINEMENT OF CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN

The Final SLERA (PBW, 2010a) concluded with the SMDP that there is a potential for adverse ecological effects from COPECs and a more thorough assessment through continuation of the ecological risk assessment process was warranted. The Final SLERA calculated HQs based on conservative screening-level assumptions, such as area-use factors (AUFs) of 100%, 100% contaminant bioavailability, maximum ingestion rates, and minimum body weights. Appendix A provides the SLERA table identifying COPECs with HQs greater than one.

As illustrated in Appendix A (Table 29 from the Final SLERA), the screening-level evaluation identified HQs greater than one for the following Site media and receptors:

- Invertebrate receptors in South Area soils (as represented by the earthworm);
- Invertebrate receptors in North Area soils (also represented by the earthworm);
- Benthic receptors in Site Intracoastal Waterway sediment (as represented by the polychaetes *Capitella capitata*);
- Benthic receptors in Site wetlands sediment (as represented by the polychaetes *Capitella capitata*);
- Invertebrate receptors in wetlands surface water (as represented by the fiddler crab *Uca rapax* and killifish *Fundulus grandis*);
- Benthic receptors in Site pond sediment (as represented by the polychaetes *Capitella capitata*); and
- Invertebrate receptors in pond surface water (as represented by the fiddler crab *Uca rapax* and killifish *Fundulus grandis*).

The Final SLERA (PBW, 2010a) concluded that upper trophic level receptors were not at risk from these COPECs.

2.1 REFINEMENT PROCEDURES

As described in EPA, 1997, the purpose of the refinement step of problem formulation is to consider how the HQs in the SLERA would change when more realistic conservative

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Deleted: <#>Invertebrate receptors in Background Area soils (again represented by the earthworm);¶

Deleted: <#>Benthic receptors in Background Intracoastal Waterway sediment (also represented by the polychaetes *Capitella capitata*);¶

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Deleted: Additionally, the maximum concentration in surface water of some COPECs is greater than the TCEQ ecological benchmark value or the TSWQS. These COPECs, acrolein, dissolved copper, and dissolved silver, are being further evaluated in the BERA and details are below. Upper

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Acrolein was measured (0.00929 mg/L) in one of four surface water samples from the wetlands. It was not detected in any surface water samples from the Intracoastal Waterway or the two ponds. The single detection is greater than the TCEQ ecological benchmark value of 0.005 mg/L by less than a factor of two. There is neither a TSWQS nor a recommended national water quality criterion from the EPA (2009) for chronic marine exposures. The maximum measured concentration of dissolved copper in surface water from the wetlands was 0.011 mg/L. It was not detected in any surface water samples from the Intracoastal Waterway or the two ponds. The maximum concentration is greater than the TSWQS of 0.0036 mg/L by about three-fold. The maximum measured concentration of dissolved silver in surface water from the ponds was 0.0029 mg/L. It was not detected in the surface water samples from the Site-related area of the Intracoastal Waterway or the wetlands. All detections are greater than the TCEQ ecological screening benchmark value of 0.00019 mg/L, the maximum being about ... [1]

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assumptions are used. As previously discussed, the Final SLERA (PBW, 2010a) concluded that upper trophic level (non-sedentary) receptors are not at risk from COPECs.

2.2 BACKGROUND COMPARISON

As part of this problem formulation, Site metal COPECs in soil and/or sediment that are remaining after the refinement (e.g., arsenic, barium, chromium, copper, lead, nickel, and zinc) were statistically compared to the same metal compounds in the background area for soil and sediment. This information was used in the development of Site-specific assessment endpoints (Section 5.0) and risk questions (Section 6.0), which will subsequently be used to develop testable hypotheses and measures as part of the study design in the WP/SAP. The COPEC concentrations in Site samples that are not statistically different from background concentrations are dismissed from further evaluation in the BERA (background data will still be discussed in the uncertainty section of the BERA report).

The soil background data were compared to soil data from the South and North Areas of the Site, as well as sediments from the North wetland and the North Area ponds. As described in the Nature and Extent Data Report (NEDR) (PBW, 2009), this comparison was appropriate based on similarities in composition and condition between background soil and sediments of the North wetlands area. Sediment and surface water data for the Intracoastal Waterway samples were compared to sediment and surface water data collected in the Intracoastal Waterway background area.

The background comparisons were performed using analysis of variance tests in accordance with EPA's *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites* (EPA, 2002). The analysis of variance tests perform a comparison of the means analysis. The null hypothesis of the background comparison test is that the concentration in samples from potentially impacted areas is less than or equal to the mean concentration in background areas. The output of these background statistical comparison tests is provided in Appendix B-1 through B-4 (South of Marlin Soil; North of Marlin Soil; Wetland Sediment; and Pond Sediment, respectively). The conclusion is that the Site concentrations of these metals COPECs are not different from the background concentrations for all metals evaluated. Nickel is retained for further evaluation because it was not analyzed in the background samples. Therefore, the only metal COPEC in soil or sediment to be further evaluated is nickel in wetlands sediment.

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Deleted: Consistent with that objective, the following modified assumptions are used here in the BERA to calculate revised HQs and refine the COPEC list, and includes the following:

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<#>Use of average (instead of maxima) ingestion rates for both media and foods consumed;¶
<#>Use of average (instead of minima) body weights for food chain receptors; and¶
<#>Use of AUFs less than 100% when it can be demonstrated that a specific receptor's home range size is greater than the size of the Site.¶
¶
The detailed spreadsheets in Appendices C through J describe the specific assumption modifications made for specific receptors and the resulting calculations. ¶
¶
All of the modified assumptions for the refinement pertain to non-sedentary ecological food-chain receptors. Results of the refinement calculations include the deletion of the avian carnivore (sandpiper) receptor for the pond sediment. The HQ calculated in the SLERA for this receptor in the pond was 1.2. With changes in the ingestion rates, body weights and AUFs, the refined lead HQ for the avian carnivore (sandpiper) receptor at the ponds was 0.96. So, the exposure pathway including media and food ingestion of lead by the avian carnivore (sandpiper) is dismissed from further evaluation. All other COPECs from the SLERA still remain for further evaluation.¶

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For the COPECs in surface water (acrolein, dissolved copper, and dissolved silver), a statistical comparison of means between Site and background data sets was not performed due to the small data set sizes (four background Intracoastal Waterway surface water samples and six pond surface water samples). However, dissolved silver was detected in all four background surface water samples at concentrations ranging from 0.0043 mg/L to 0.006 mg/L, while the maximum reported dissolved silver concentration in pond surface water samples was a lower value of 0.0029 mg/L. Based on this observation that all the pond surface water sample concentrations were less than the minimum background concentration, dissolved silver in pond surface water is dismissed from further evaluation in the BERA.

2.3 SPATIAL DISTRIBUTION OF REMAINING COPECs

In order to evaluate potential hotspots and the spatial distributions of the remaining COPECs, HQ exceedances in individual samples are plotted by environmental medium in Figures 5 through 9. For soils, the HQs are based on no-observed-adverse-effects-levels (NOAELs). For sediments, HQs are based on marine benchmarks (e.g., Effects Range-Low [ERL]) from TCEQ (2006), where available, or other sediment quality guidelines (e.g., Apparent Effects Thresholds [AET]) from Buchman (2008). The paragraphs below discuss the spatial trends of the HQ exceedances observed in the figures.

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Figure 5 shows HQ exceedances for soil invertebrates in the South Area. As indicated on this figure, the highest HQs and most of the exceedances are located near the former dry dock in the northwestern part of the South Area. As shown on Figure 5, most of those samples are from the side embankments of the dry dock itself, where the soils consist of compacted engineered fill. Other samples with exceedances in the South Area, namely those off the northeastern end of the westernmost barge slip and between the western and eastern barge slips, are also from areas devoid of vegetation where the soil is compacted from engineered fill or for use as a driveway. The highest HQ is 26 for 4,4'-DDD in sample SA3SB17. All other HQs were less than or equal to 5 and nearly 75 percent were less than or equal to 2. These areas of side embankments, engineered fill, and driveways are not considered habitat for soil invertebrates. Therefore, the exposure pathway is considered incomplete and the associated COPECs (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Aroclor-1254, and HPAH) are dismissed from further consideration for South Area

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soils in the BERA. At this point, South Area soils have no remaining COPECs, so this area/medium requires no further evaluation in the BERA.

Figure 6 shows HQ exceedances for soil invertebrates in the North Area. As indicated on this figure, the only HQ exceedances are 4,4'-DDT and Aroclor-1254 in the 1.5 to 2.0 foot depth interval sample from SB-204. This boring was located in an area where buried debris was observed and some of this debris (painted wood fragments and rubber) was observed in this specific sample interval.

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Figure 7 shows HQ exceedances for benthic receptors in Site Intracoastal Waterway sediment. None of the HQs are greater than 5 and 75 percent are less than or equal to 2. As indicated on this figure, the HQs greater than one are nearly all PAHs, except for 4,4'-DDT in a sample next to the western boundary of the Site and hexachlorobenzene on the edge of the eastern barge slip, and most are associated with samples in the northern end of the western barge slip.

Figure 8 shows HQ exceedances for benthic receptors in Site wetland sediment. As shown in this figure, the predominant and highest HQs are associated with PAHs (both individual PAHs and low molecular weight PAHs (LPAH), HPAH, and total PAHs). Most of the PAH HQ exceedances are located in three areas: (1) a small area immediately northeast of the former surface impoundment (where most of the highest PAH HQs are observed; e.g., 2WSED2); (2) a smaller area immediately south of the former surface impoundments (e.g., 2WSED17); and (3) at sample location NB4SE08 in the southwest part of the North Area. The three highest HQs, all located in the area north of the former surface impoundments, are for dibenz(a,h)anthracene.

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Figure 9 shows HQ exceedances for benthic receptors in pond sediment. As shown in this figure, the sole HQ exceedance is for 4,4'-DDT in the southernmost sample from the Small Pond.

There are two COPECs, total acrolein and dissolved copper, with maximum concentrations that exceed their respective ecological screening benchmark and TSWQS. Acrolein was detected once in four surface water samples from the wetlands area, and not detected in any other Site samples. Dissolved copper was detected in three of four surface water samples from the wetlands area. All of the detections are greater than the TSWQS, the highest being about three times greater. Both acrolein and dissolved copper are retained for further evaluation in the BERA.

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After the refinement steps detailed above, the remaining COPECs, and their environmental medium and location, are listed in Table 1 (soil) and Table 2 (sediment).

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3.0 CHARACTERIZATION OF ECOLOGICAL EFFECTS

The Final SLERA (PBW, 2010a) included a literature search of potential ecological effects from the initial COPECs. As part of problem formulation in the BERA, additional literature information related to the remaining Site COPECs was obtained and reviewed.

The Final SLERA (PBW, 2010a) concluded that upper trophic level receptors were not at risk from these COPECs. For sediment invertebrates, benchmarks (e.g., ERLs) from TCEQ (2006) were used. If a marine/estuarine benchmark was not available, sediment quality guidelines from Buchman (2008) were selected.

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A number of researchers have performed studies to determine AETs, which are measures of sediment effect levels developed using the empirical data from the results of toxicity tests and benthic community structure. They are derived by determining, for a given chemical within a data set, the chemical sediment concentration above which a particular adverse biological effect is always statistically significant relative to a designated reference location.

ERLs and ERMs are also statistically-derived sediment benchmark values based on a variety of benthic endpoints including mortality, community structure, reproductive, and other effects. These sediment quality guidelines are intended as informal (i.e., non-regulatory) benchmarks to aid in the interpretation of chemical data. Low-range values (i.e., ERLs) are intended as concentrations below which adverse effects upon sediment-dwelling fauna would be expected only infrequently. ERMs, on the other hand, are intended to represent chemical concentrations above which adverse effects are likely to occur (Long and MacDonald, 1998).

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4.0 CONTAMINANT FATE AND TRANSPORT AND ECOSYSTEMS POTENTIALLY AT RISK

The Final SLERA (PBW, 2010a) included a preliminary evaluation of contaminant fate and transport, ecosystems potentially at risk, and complete exposure pathways for COPECs and media that might pose an adverse risk to terrestrial and aquatic receptors. The exposure pathways and ecosystems associated with the assessment endpoints carried forward from the SLERA were evaluated in more detail in this problem formulation. Consistent with EPA (1997), this evaluation also considered the possible reduction of potentially complete, but less significant, exposure pathways to examine the critical exposure pathways, where appropriate. The findings of this evaluation are presented below.

4.1 CONTAMINANT FATE AND TRANSPORT

Additional information was acquired from the scientific literature regarding the fate and transport of the remaining COPECs. Specifically, details about transport mechanisms in terrestrial and aquatic systems similar to those found at the Site were obtained and are discussed below.

4.1.1 Potential Transport Mechanisms in Terrestrial Systems

Potentially significant routes of migration for Site COPECs relative to terrestrial systems occur in the primary transport media of air and surface water (runoff). Surface water runoff, or overland flow, can carry dissolved COPECs in solution or move COPECs adsorbed to soil particles from one portion of the Site to another, depending on surface topography. The same mechanisms described for overland flow in the wetlands (Section 4.1.2) apply to the South Area and the upland areas of the North Area. Airborne transport of Site COPECs is possible via entrainment of COPEC-containing particles in wind. This pathway is a function of particle size, chemical concentrations, moisture content, degree of vegetative cover, surface roughness, size and topography of the source area, and meteorological conditions (wind velocity, wind direction, wind duration, precipitation, and temperature). Movement of airborne contaminants occurs when wind speeds are high enough to dislodge particles; higher wind velocities are required to dislodge particles than are necessary to maintain suspension.

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4.1.2 Potential Transport Mechanisms in Estuarine Wetland and Aquatic Systems

Potentially significant routes of migration for Site COPECs relative to wetland and aquatic systems occur in the primary transport media of surface water and sediment. The primary surface water/sediment pathways for potential contaminant migration from Site potential source areas (PSAs) are: (1) erosion/overland flow to wetland areas north and east of the Site from the North Area due to rainfall runoff and storm/tide surge; and (2) erosion/overland flow to the Intracoastal Waterway from the South Area as a result of rainfall runoff and extreme storm surge/tidal flooding events.

The primary North Area PSAs, the former surface impoundments, were closed and capped in 1982. Thus, potential migration from these areas to the adjacent wetlands would have to have occurred during the operational period of the impoundments, potentially when discharges from the impoundments in July 1974 and August 1979 reportedly "contaminated surface water outside of ponds" and "damaged some flora north of the ponds" (EPA, 1980). Although not associated with Site operations, the historical and ongoing spraying of pesticides in the wetland areas for mosquito control could represent a potential source of DDT and PAHs (associated with the light oil base and diesel carrier used in spraying then and now, respectively) to the wetlands.

Overland flow during runoff events occurs in the direction of topographic slope. Overland flow during runoff events occurs if soils are fully saturated and/or precipitation rates are greater than infiltration rates; therefore, this type of flow is usually associated with significant rainfall events. As a result of the minimal slope at the site, overland flow during more routine rainfall events is generally low, with runoff typically ponding in many areas of the Site. Extreme storm events, such as Hurricane Ike in September 2008, can inundate the Site, resulting in overland flow during both storm surge onset and recession. During less extreme storm surge events or unusually high tides, tidal flow to wetland areas on and adjacent to the Site occurs from Oyster Creek northeast of the Site (Figure 1); however, the wetland areas are more typically hydrologically isolated from Oyster Creek.

Potential contaminant migration in surface water runoff can occur as both sediment load and dissolved load; therefore, both the physical and chemical characteristics of the contaminants are important with respect to surface-water/sediment transport. The low topographic slope of the Site and adjacent areas is not conducive to high runoff velocities or high sediment loads.

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Consequently, surface soil particles would not be readily transported in the solid phase. Additionally, the vegetative cover in the North Area is not conducive to significant soil erosion and resulting sediment load transport with surface water in these areas. Dissolved loads associated with surface runoff from the North Area would likewise be expected to be minimal due to the aforementioned absence of exposed PSAs, and the relatively low solubilities of those COPECs (primarily, pesticides and PAHs) that are present.

4.1.3 COPEC-Specific Fate and Transport Characteristics

PAHs. A detailed literature review related to PAH fate and transport characteristics in similar settings to the Site was performed for the ecological problem formulation for the Alcoa (Point Comfort)/Lavaca Bay Superfund Site (Alcoa, 2000). That document (used with permission) provided significant parts of the summary presented herein. Due to their low solubility and relatively high affinity for adsorption to soils, sediment organic matter, PAHs in the aquatic environment are primarily associated with particulate matter and sediments (Neff, 1985). PAHs sorb to both inorganic and organic surfaces, although adsorption to organic surfaces tends to be most important. PAH adsorption to particulate mater, especially HPAHs, is a primary mechanism for removing these compounds from the water column, resulting in subsequent deposition to sediments. PAH sorption to sediments is strongly influenced by sediment organic carbon content. PAH sorption is also influenced by particle size (Karickhoff et al., 1979); the smaller the particle size, the greater the adsorption potential.

Benthic organisms accumulate PAHs by two primary exposure routes: (1) bioconcentration through transport across biological membranes exposed to aqueous phase PAHs (i.e., pore water); and (2) bioaccumulation through direct food or sediment ingestion. For benthic organisms, direct ingestion of food and/or sediments is often the most significant exposure pathway for HPAHs (Niimi and Dookhran, 1989; Eadie et al., 1985; Weston, 1990), while pore water is likely a more significant route for LPAH accumulation (Meador et al., 1995b; Adams, 1987; Landrum, 1989). Differences in feeding regime (i.e., epibenthic, infaunal) also influence which exposure route is most significant.

As a result of these issues, PAH accumulation by benthic organisms can vary. In addition, the degree to which organisms accumulate PAHs depends on their ability to metabolize these compounds. Although some organisms metabolize PAHs (e.g., fish and mammals), many benthic

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invertebrates are limited in their ability to metabolize PAHs (Meador et al., 1995a; Landrum, 1982; Frank et al., 1986).

In general, there is little evidence to suggest PAHs biomagnify in aquatic systems. However, because of the limited ability of invertebrates to metabolize PAHs, some biomagnification may occur in lower trophic levels (Meador et al., 1995a; McElroy et al., 1989; Broman et al., 1990; Suede et al., 1994). Although metabolism often results in detoxification, some PAH metabolites are more toxic than parent materials; however, the degree to which these metabolites are accumulated by aquatic organisms is unknown.

Organochlorine Pesticides and PCBs. Organochlorine pesticides and PCBs are of interest in characterizations of risk to ecological receptors due to the affinity of these compounds to sorb tightly onto soils and sediments and persist for long periods of time in the environment. The degradation of organochlorine compounds in the environment is dependent on the degree and pattern of chlorination, with compounds possessing five or more chlorine atoms more persistent in the environment than those with fewer chlorine atoms.

Benthic invertebrate communities are particularly susceptible to organochlorine compound impacts as consequence of ingestion of sediment particles and exchange of PCBs directly from the particles. The silt and clay content of sediments can have a significant influence on the bioavailability of organochlorine compounds, with low silt and clay content sediments exhibiting decreased effects on benthic communities (Eisler, 1986). Due to bioaccumulative properties, organochlorine compounds cycle readily from sediment sources into upper trophic levels. This class of compounds are soluble in lipids and partition readily into the fatty tissues of higher-level consumers, with the ability to be metabolized decreasing as the number of substituted chlorines increases. For highly substituted compounds, metabolism is less likely and accumulation may continue indefinitely. The fate of organochlorine compounds within biologic systems is wide ranging as a result of differences in the ability to accumulate, metabolize, and eliminate specific isomers.

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4.2 ECOSYSTEMS POTENTIALLY AT RISK

Based on the remaining HQ exceedances listed in Tables 1 and 2, and in consideration of the ecological effects literature evaluation (Section 3.0), the fate and transport characteristics (Section 4.1), and the nature of the ecosystems themselves, the following ecosystems have been identified as potentially at risk:

- Localized wetland areas in the North Area and north of the Site. The primary COPECs with HQ exceedances in wetland sediment are several PAHs (Table 2). As shown on Figure 8, most of the PAH HQs are located in three areas: (1) a small area immediately northeast of the former surface impoundments (where most of the highest PAH HQs are observed; e.g., 2WSED2); (2) a smaller area immediately south of the former surface impoundments (e.g., 2WSED17); and (3) at sample location NB4SE08 in the southwest part of the North Area approximately 60 feet north of Marlin Avenue. Additionally, total acrolein and dissolved copper in wetland surface water in the first area (the area northeast of the former surface impoundments) exceed their respective surface water benchmark and TSWQS.

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- Localized areas of Intracoastal Waterway sediment within the former barge slips. The predominant COPECs in these areas, as reflected by HQ exceedances (Table 2), are PAHs. The total PAH concentration (5.62 mg/kg) was highest in the northernmost sample in the western barge slip. In the eastern barge slip, exceedances were limited to three PAHs , hexachlorobenzene, and HPAHs in one sample.

- Localized area of North Area soils south of the former surface impoundments. As previously described (Section 2.3), the only HQs are 4,4'-DDT and Aroclor-1254 in the 1.5 to 2.0 foot depth interval sample from SB-204. This boring was located in an area where buried debris was observed and some of this debris (painted wood fragments and rubber) was observed in this specific sample interval.

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5.0 SITE-SPECIFIC ASSESSMENT ENDPOINTS

Assessment endpoints are explicit expressions of the ecological resource to be protected for a given receptor of potential concern (EPA, 1997). Several assessment endpoints were identified in the SLERA to focus the screening evaluation on relevant receptors rather than attempting to evaluate risks to all potentially affected ecological receptors. As part of this BERA problem formulation, these assessment endpoints were re-evaluated based on the remaining environmental media and receptors of potential concern.

5.1 TERRESTRIAL ASSESSMENT ENDPOINTS

The terrestrial portion associated with the Site that remains of concern is a small area of land south of the former surface impoundments. The environmental value of upland lands is related to its ability to support plant communities, soil microbes/detritivores, and wildlife. Based on the steps taken in the refinement (Section 2.0) and new information obtained about COPEC fate and transport and ecosystems at risk (Section 4.0), the following remains the assessment endpoint for the BERA (Table 3):

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- *Soil invertebrates abundance, diversity, and productivity* (as decomposers and food chain base, among others) are ecological values to be preserved in a terrestrial ecosystem because they provide a mechanism for the physical and chemical breakdown of detritus for microbial decomposition (remineralization), which is a vital function.

5.2 ESTUARINE WETLAND AND AQUATIC ASSESSMENT ENDPOINTS

The estuarine wetland habitat for the Site extends over the majority of the North Area while the Intracoastal Waterway (i.e., aquatic habitat) is south of the Site. Wetlands are particularly important habitat because they often serve as a filter for water prior to it going into another water body. They are also important nurseries for fish, crab, and shrimp, and they act as natural detention areas to prevent flooding. The environmental value for these areas is related to their ability to support wetland plant communities, microbes/benthos/detritivores in the sediment, and wildlife. Based on the steps taken in the refinement (Section 2.0) and new information obtained about COPEC fate and transport and ecosystems at risk (Section 4.0), the following remains the assessment endpoint for the BERA (Table 3):

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- *Benthos abundance, diversity, and productivity* are values to be preserved in estuarine ecosystems because these organisms provide a critical pathway for energy transfer from detritus and attached algae to other omnivorous organisms (e.g., polychaetes and crabs) and carnivorous organisms (e.g., black drum and sandpipers), as well as integrating and transferring the energy and nutrients from lower trophic levels to higher trophic levels. The most important service provided by benthic detritivores is the physical breakdown of organic detritus to facilitate microbial decomposition.

6.0 CONCEPTUAL SITE MODEL AND RISK QUESTIONS

6.1 CONCEPTUAL SITE MODEL

Preliminary Conceptual Site Models (CSMs) for the aquatic and terrestrial ecosystems were described in the SLERA. During problem formulation in the BERA, these CSMs have been updated to consider the results of the COPEC refinement (Section 2.0), expanded review of potential ecological effects of those COPECs (Section 3.0), and the more detailed fate and transport evaluation (Section 4.0). Updated CSMs based on these considerations are shown on Figures 10 and 11. These CSMs are discussed below.

The identification of potentially complete exposure pathways is performed to evaluate the exposure potential as well as the risk of effects on ecosystem components. In order for an exposure pathway to be considered complete, it must meet all of the following four criteria (EPA, 1997):

- A source of the contaminant must be present or must have been present in the past.
- A mechanism for transport of the contaminant from the source must be present.
- A potential point of contact between the receptor and the contaminant must be available.
- A route of exposure from the contact point to the receptor must be present.

Exposure pathways can only be considered complete if all of these criteria are met. If one or more of the criteria are not met, there is no mechanism for exposure of the receptor to the contaminant. The potentially complete and significant exposure pathways and receptors that match the current assessment endpoints are shown in the CSM for the terrestrial and estuarine wetland and aquatic ecosystems (Figures 10 and 11, respectively).

In general, biota can be exposed to chemical stressors through direct exposure to abiotic media or through ingestion of forage or prey that have accumulated contaminants. Exposure routes are the mechanisms by which a chemical may enter a receptor's body. Possible exposure routes include 1) absorption across external body surfaces such as cell membranes, skin, integument, or cuticle from the air, soil, water, or sediment; and 2) ingestion of food and incidental ingestion of soil, sediment, or water along with food. Absorption is especially important for plants and aquatic life.

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The terrestrial ecosystem CSM (Figure 10) begins with historical releases of the COPECs from the former surface impoundments and operations areas in the North and South Areas. Soil became contaminated with the COPECs and contaminated soil was transported from its original location to other portions of the Site via the transport mechanisms of surface runoff and airborne suspension/deposition. The significant potential receptors (soil invertebrates) are then exposed to soils in their original location or otherwise via direct contact or ingestion of soil.

The aquatic ecosystem CSM (Figure 11) begins with historical releases of the COPECs from barge cleaning operations that impacted sediment in the barge slips of the Intracoastal Waterway and surface water and sediment in the North Area wetlands. These areas were impacted via the primary release mechanisms of direct discharge from past operations, surface runoff, and particulate dust/volatile emissions. Tidal flooding and rainfall events created secondary release mechanisms of resuspension/deposition, bioirrigation, and bioturbation, such that other areas of surface water and sediment became contaminated. The significant potential receptors (sediment and water-column invertebrates) are then exposed to the contaminated surface water and sediment in their original location or otherwise via direct contact or ingestion of surface water and sediment.

6.2 RISK QUESTIONS

As described in ecological risk assessment guidance (EPA, 1997), risk questions for the BERA are questions about the relationships among assessment endpoints and their predicted responses when exposed to contaminants. As such, the risk questions are based on the assessment endpoints and provide a basis for the ecological investigation study design developed in the BERA WP/SAP.

The overarching risk question to be evaluated in the BERA is whether Site-related contaminants are causing, or have the potential to cause, adverse effects on the invertebrates in North Area soils and on benthos and zooplankton of the wetlands area and the barge slips of the Intracoastal Waterway. For problem formulation, this overarching question is refined into a series of specific questions referencing specific COPECs and the assessment endpoint. Preliminary risk questions were developed for the Final SLERA (PBW, 2010a). Based on the information developed for this problem formulation, these risk questions were refined to the questions identified in Table 3 of this report. Testable hypotheses and measures of effect for these questions will be developed

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in the WP/SAP. The risk questions of concern for the end of the BERA Problem Formulation are the following:

- Does exposure to COPECs in soil adversely affect the abundance, diversity, productivity, and function of soil invertebrates?

- Does exposure to COPECs in sediment and surface water adversely affect the abundance, diversity, productivity, and function of sediment and water-column invertebrates?

7.0 SCIENTIFIC MANAGEMENT DECISION POINT

The final component of BERA problem formulation is an SMDP. The SMDP entails identification and agreement on the COPECs, assessment endpoints, exposure pathways, and risk questions that have been described in previous sections. As discussed above, the ecosystems potentially at risk for adverse effects are 1) localized areas of sediment within the Site barge slips (primarily due to PAHs); 2) localized wetland areas (primarily due to PAHs and pesticides), mainly northeast of the former surface impoundments and north of Marlin Avenue; and 3) a localized area of soils south of the former surface impoundments in the North Area.

A Removal Action Work Plan has been finalized and is ready to be implemented upon execution of the Removal Action Settlement Agreement. This Removal Action is intended to: (1) address the aboveground storage tank farm in the South Area of the Site; and (2) facilitate repair of the existing cap on the former surface impoundments in the North Area of the Site. Implementation of the removal action in the North Area, as well as the nature of the disturbed habitat in the South Area and past, current, and anticipated future land use (including restrictive covenants for only commercial/industrial land use), obviates the need for further consideration of soil exposure pathways.

The list of COPECs that will be addressed in the WP/SAP to obtain additional site-specific information is presented in Table 4.

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ATTACHMENT C

REDLINE/STRIKEOUT OF FINAL BASELINE ECOLOGICAL RISK ASSESSMENT WORK PLAN & SAMPLING AND ANALYSIS PLAN TEXT RELATIVE TO TEXT OF MARCH 10, 2010 DRAFT

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FINAL BASELINE ECOLOGICAL RISK ASSESSMENT WORK PLAN & SAMPLING AND ANALYSIS PLAN

FOR THE
GULFCO MARINE MAINTENANCE
SUPERFUND SITE
FREEPORT, TEXAS

PREPARED BY:

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2201 Double Creek Drive, Suite 4004¶
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MAY 10, 2010

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LIST OF TABLES

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LIST OF FIGURES

LIST OF APPENDICES

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LIST OF ACRONYMS

AST – above ground storage tank

AVS/SEM – Acid Volatile Sulfide/Simultaneously Extracted Metals

BERA – Baseline Ecological Risk Assessment

CAS – Columbia Analytical Laboratory

COC – chain of custody

COPEC – contaminants of potential ecological concern

CSM – conceptual site model

DDT – dichlorodiphenyltrichloroethane

DQO – Data Quality Objective

EDD – electronic data deliverable

Eh – redox potential

EPA – United States Environmental Protection Agency

FSP – field sampling plan

HPAH – high-molecular weight polynuclear aromatic hydrocarbon

HQ – hazard quotient

LCS – laboratory control sample

LCSD - laboratory control sample duplicate

LPAH – low-molecular weight polynuclear aromatic hydrocarbon

MQL – method quantitation limit

MS – matrix spike

MSD – matrix spike duplicate

NPL – National Priorities List

PAH – polynuclear aromatic hydrocarbon

QAPP – Quality Assurance Project Plan

RI/FS – Remedial Investigation/Feasibility Study

RPD – relative percent difference

SAP – Sampling and Analysis Plan

SLERA – Screening-Level Ecological Risk Assessment

SMDP – Scientific Management Decision Point

SOW – Statement of Work

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AF $_{soil/sediment}$ – chemical bioavailability factor from soil/sediment (unitless)¶

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Deleted: BAF – bioaccumulation factor¶

Deleted: BSAF – biota-sediment accumulation factor¶
BW – wildlife receptor body weight (kg)¶
C $_{food}$ – chemical concentration in food (mg/kg)¶
C $_{soil/sediment}$ – chemical concentration in soil/sediment (mg/kg)¶
COI – chemicals of interest¶

Deleted: DDD – dichlorodiphenyldichloroethylene¶
DDE – dichlorodiphenyldichloroethane¶

Deleted: EPC – exposure point concentration¶
ERA – Ecological Risk Assessment¶
ERL – effects range low¶
ERM – effects range medium¶

Deleted: IR $_{food}$ – food ingestion rate (kg/day)¶
IR $_{soil/sediment}$ – soil/sediment ingestion rate (kg/day)¶
LOAEL – lowest observable effects level¶

Deleted: NEDR – Nature and Extent Data Report¶
NOAEL – no observable adverse effects level¶

Deleted: PCB – polychlorinated biphenyl¶
PCL – Protective Concentration Level¶
PSA – Potential Source Area¶

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ROPC – receptors of potential concern¶
SEL – Second Effects Level¶

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TCEQ – Texas Commission on Environmental Quality

TOC – total organic carbon

UAO – Unilateral Administrative Order

USFWS – United States Fish and Wildlife Service

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TPWD – Texas Parks and Wildlife Department¶
TRV – species-specific toxicity reference value¶
TSWQS – Texas Surface Water Quality Standard¶

Deleted: UCL – upper confidence limit¶
USDA – United States Department of Agriculture¶

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1.0 INTRODUCTION

The United States Environmental Protection Agency (EPA) named the former site of Gulfco Marine Maintenance, Inc. in Freeport, Brazoria County, Texas (the Site) to the National Priorities List (NPL) in May 2003. The EPA issued a modified Unilateral Administrative Order (UAO), effective July 29, 2005, which was subsequently amended effective January 31, 2008. The UAO required Respondents to conduct a Remedial Investigation and Feasibility Study (RI/FS) for the Site. Pursuant to Paragraph 37(d)(x) of the Statement of Work (SOW) for the RI/FS, included as an Attachment to the UAO, a May 3, 2010 Final Screening Level Ecological Risk Assessment (SLERA) was prepared for the Site (PBW, 2010a). The Scientific/Management Decision Point (SMDP) provided in the Final SLERA concluded that the information presented therein indicated a potential for adverse ecological effects, and a more thorough assessment was warranted. This Final Baseline Ecological Risk Assessment (BERA) Work Plan & Sampling and Analysis Plan has been prepared, consistent with Paragraphs 37(d)(xi) and (xii) of the UAO as the next step in that assessment. This report was originally prepared by Pastor, Behling & Wheeler, LLC (PBW, 2010b), on behalf of LDL Coastal Limited LP (LDL), Chromalloy American Corporation (Chromalloy) and The Dow Chemical Company (Dow), collectively known as the Gulfco Restoration Group (GRG). This May 10, 2010 revision has been prepared by URS Corporation (URS) based on comments received from the EPA and the Texas Commission on Environmental Quality (TCEQ).

1.1 REPORT PURPOSE

Following completion of the SLERA, the BERA Problem Formulation was conducted to identify the specific ecological issues at the Site and determine the scope and goals of the BERA in accordance with Paragraph 37(d)(xi) (Step 3) of the SOW for the RI/FS. The BERA Problem Formulation further refined or identified contaminants of ecological concern, ecological effects of contaminants, fate and transport, assessment endpoints, and the Conceptual Site Model (CSM). The CSM was used to develop an investigation plan and establish the data requirements and data quality objectives to be achieved through the BERA. This Work Plan has been prepared to describe the CSM and the investigation components necessary to complete the BERA. The Work Plan includes a Sampling and Analysis Plan (SAP) that establishes the specific sampling locations, equipment, and procedures to be used during the BERA.

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Per EPA direction, this Final BERA Work Plan and SAP is being submitted concurrent with the May 10, 2010 Final BERA Problem Formulation Report (URS, 2010). As such, the investigation activities proposed herein may be subject to revision based on review comments and revisions to the Final BERA Problem Formulation Report. Also, a Removal Action Work Plan has been finalized and is ready to be implemented upon execution of the Removal Action Settlement Agreement. This Removal Action is intended to: (1) address the aboveground storage tank farm (AST Tank Farm) in the South Area of the Site; and (2) facilitate repair of the existing cap on the former surface impoundments in the North Area of the Site. Implementation of the removal action in the North Area, as well as the nature of the disturbed habitat in the South Area and past, current, and anticipated future land use (including restrictive covenants for only commercial/industrial land use), obviates the need for further consideration of soil exposure pathways.

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The objective of this Work Plan and SAP is to document the decisions and evaluations made during the BERA Problem Formulation and to identify the additional investigation activities needed to complete the evaluation of ecological risks. This Work Plan and SAP presents the conclusions of the Final BERA Problem Formulation, and the methods and procedures necessary to complete the BERA based on those conclusions. This Work Plan and SAP includes the general scope of activities to be conducted during the BERA, and a detailed description of the sampling and data-gathering procedures.

1.2 SITE BACKGROUND

The Site is located in Freeport, Texas at 906 Marlin Avenue (also referred to as County Road 756) (Figure 1). The Site consists of approximately 40 acres along the north bank of the Intracoastal Waterway between Oyster Creek (approximately one mile to the east) and the Texas Highway 332 bridge (approximately one mile to the west). The Site includes approximately 1,200 feet (ft.) of shoreline on the Intracoastal Waterway, the third busiest shipping canal in the US (TxDOT, 2001) that, on the Texas Gulf Coast, extends 423 miles from Port Isabel to West Orange.

Marlin Avenue divides the Site into two primary areas (Figure 2). For the purpose of descriptions in this report, Marlin Avenue is approximated to run due west to east. The property to the north of Marlin Avenue (the North Area) consists of undeveloped land and closed surface

impoundments, while the property south of Marlin Avenue (the South Area) was developed for industrial uses with multiple structures, a dry dock, sand blasting areas, an aboveground storage tank (AST) tank farm, and two barge slips connected to the Intracoastal Waterway.

Adjacent property to the north, west, and east of the North Area is undeveloped. Adjacent property to the east of the South Area is currently used for industrial purposes while to the west the property is currently vacant and previously served as a commercial marina. The Intracoastal Waterway bounds the Site to the south. Residential areas are located south of Marlin Avenue, approximately 300 feet west of the Site, and 1,000 feet east of the Site.

The South Area includes approximately 20 acres of upland that was created from dredged material from the Intracoastal Waterway. The two most significant surface features within the South Area are a Former Dry Dock and the AST Tank Farm. The remainder of the South Area surface consists primarily of former concrete laydown areas, concrete slabs from former Site buildings, gravel roadways and sparsely vegetated open areas with some localized areas of denser brush vegetation, particularly near the southeast corner of the South Area.

Some of the North Area is upland created from dredge spoil, but most of this area is considered wetlands, as per the United States Fish and Wildlife Service (USFWS) Wetlands Inventory Map (USFWS, 2008). This wetland area generally extends from East Union Bayou to the southwest, to the Freeport Levee to the north, to Oyster Creek to the east (see Figure 1). The most significant surface features in the North Area are two ponds (the Fresh Water Pond and the Small Pond) and the closed former surface impoundments. The former surface impoundments and the former parking area south of the impoundments and Marlin Avenue comprise the vast majority of the upland area within the North Area.

Field observations during the RI indicate that the North Area wetlands are irregularly flooded with nearly all of the wetland area inundated by surface water that can accumulate to a depth of one foot or more during extreme high tide conditions, storm surge events, and/or in conjunction with surface flooding of Oyster Creek northeast of the Site. Due to a very low topographic slope and low permeability surface sediments, the wetlands are also very poorly draining and can retain surface water for prolonged periods after major rainfall events. Under normal tide conditions and during periods of normal or below normal rainfall, standing water within the wetlands (outside of

the two ponds discussed below) is typically limited to a small, irregularly shaped area immediately north of the Fresh Water Pond and a similar area immediately south of the former surface impoundments. Both of these areas can be completely dry, as was observed in June 2008. As such, given the absence of any appreciable areas of perennial standing water, the wetlands are effectively hydrologically isolated from Oyster Creek, except during intermittent, and typically brief, flooding events.

The Fresh Water Pond is approximately 4 to 4.5 feet deep and is relatively brackish (specific conductance of approximately 40,000 umhos/cm and salinity of approximately 25 parts per thousand). This pond appears to be a borrow pit created by the excavation of soil and sediment as suggested by the well-defined pond boundaries and relatively stable water levels. Water levels in the Fresh Water Pond are not influenced by periodic extreme tidal fluctuations as the pond dikes preclude tidal floodwaters in the wetlands from entering the pond, except for extreme storm surge events, such as observed during Hurricane Ike in September 2008.

The Small Pond is a very shallow depression located in the eastern corner of the North Area. The Small Pond is not influenced by daily tidal fluctuations and behaves in a manner consistent with the surrounding wetland, i.e., becomes dry during dry weather, but retains water in response to and following rainfall and extreme tidal events. Water in the Small Pond is less brackish based on specific conductance (approximately 14,000 umhos/cm) and salinity (approximately eight parts per thousand) measurements.

1.3 REPORT ORGANIZATION

This Work Plan and SAP has been organized in a manner consistent with the recommendation presented in the EPA guidance for conducting ecological risk assessments (EPA, 1997), which is based on the EPA guidance for risk assessments and the EPA guidance for conducting RI/FS studies under CERCLA. A discussion of the Site presented in Section 1. Section 2 presents the Work Plan, including the Conceptual Site Model (CSM), assessment endpoints, risk questions and testable hypotheses, and measurement endpoints. An overview of the ecological investigation design, including the data quality objectives established for the study, are presented in Section 3. The Field Sampling Plan (FSP), which details the sampling types and objectives, sampling location, timing, and frequency, sample designation, sampling equipment and

procedures, and sample handling, is presented in Section 4. The Quality Assurance Project Plan (QAPP) is included as Section 5. Health and safety procedures are discussed in Section 6.

2.0 WORK PLAN

2.1 CONCEPTUAL SITE MODEL

Preliminary CSMs for the aquatic and terrestrial ecosystems were described in the SLERA. During problem formulation, these CSMs were updated to consider the results of the contaminants of potential ecological concern (COPEC) refinement, expanded review of potential ecological effects of those COPECs, and the more detailed fate and transport evaluation. Updated CSMs based on these considerations are shown on Figures 3 and 4. These CSMs are discussed below.

The identification of potentially complete exposure pathways is performed to evaluate the exposure potential as well as the risk of effects on ecosystem components. In order for an exposure pathway to be considered complete, it must meet all of the following four criteria (EPA, 1997):

- A source of the contaminant must be present or must have been present in the past.
- A mechanism for transport of the contaminant from the source must be present.
- A potential point of contact between the receptor and the contaminant must be available.
- A route of exposure from the contact point to the receptor must be present.

Exposure pathways can only be considered complete if all of these criteria are met. If one or more of the criteria are not met, there is no mechanism for exposure of the receptor to the contaminant. Potentially complete pathways are shown in the conceptual site models for the terrestrial and estuarine ecosystems (Figures 3 and 4, respectively).

In general, biota can be exposed to chemical stressors through direct exposure to abiotic media or through ingestion of forage or prey that have accumulated contaminants. Exposure routes are the mechanisms by which a chemical may enter a receptor's body. Possible exposure routes include 1) absorption across external body surfaces such as cell membranes, skin, integument, or cuticle from the air, soil, water, or sediment; and 2) ingestion of food and incidental ingestion of soil, sediment, or water along with food. Absorption is especially important for plants and aquatic life.

The terrestrial ecosystem CSM (Figure 3) begins with historical releases of the COPECs from the former surface impoundments and operations areas in the North and South Areas. Soil became contaminated with the COPECs and contaminated soil was transported from its original location to other portions of the Site via the transport mechanisms of surface runoff and airborne suspension/deposition. The significant potential receptors (soil invertebrates) are then exposed to soils in their original location or otherwise via direct contact or ingestion of soil. As previously discussed in Section 1.1, implementation of the removal action in the North Area, as well as the nature of the disturbed habitat in the South Area and past, current, and anticipated future land use (including restrictive covenants for only commercial/industrial land use), obviates the need for further consideration of soil exposure pathways.

The aquatic ecosystem CSM (Figure 4) begins with historical releases of the COPECs from barge cleaning operations that impacted sediment in the barge slips of the Intracoastal Waterway and surface water and sediment in the North Area wetlands. These areas were impacted via the primary release mechanisms of direct discharge from past operations, surface runoff, and particulate dust/volatile emissions. Tidal flooding and rainfall events created secondary release mechanisms of resuspension/deposition, bioirrigation, and bioturbation, such that other areas of surface water and sediment became contaminated. The significant potential receptors (sediment and water-column invertebrates) are then exposed to the contaminated surface water and sediment in their original location or otherwise via direct contact or ingestion of surface water and sediment. The Final SLERA (PBW, 2010a) concluded that there are no unacceptable risks to upper trophic level receptors in any of the aquatic areas.

2.2 ASSESSMENT ENDPOINTS

Assessment endpoints are explicit expressions of the ecological resource to be protected for a given receptor of potential concern (EPA, 1997). Assessment endpoints were identified in the SLERA to focus the screening evaluation on sensitive and susceptible receptors rather than attempting to evaluate risks to all potentially affected ecological receptors. As part of the problem formulation, these assessment endpoints were further refined. The site-specific assessment endpoints are presented in Section 5 of the Problem Formulation and included in Table 1 of this Work Plan.

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2.3 RISK QUESTIONS

Ecological risk questions are proposed regarding assessment endpoints and their response to COPECs. These questions are used to guide the study design, evaluate the study results, and perform the risk characterization (EPA, 1997). Risk questions are posed for the assessment endpoints established for the BERA, as presented in the BERA problem formulation and are listed below:

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1. Does exposure to COPECs in soil adversely affect the abundance, diversity, productivity and function of the soil invertebrate community? – This risk question is not addressed through this assessment but is mitigated by the proposed remedial action, as previously discussed.
2. Does exposure to COPECs in sediment and surface water adversely affect the abundance, diversity, productivity and function of the benthic invertebrate community?
3. Does exposure to COPECs in sediment and surface water adversely affect the abundance, diversity, productivity and function of the fish community?

2.4 MEASUREMENT ENDPOINTS

The definition of measurement endpoints has evolved over time to include measures of ecosystem characteristics, life-history considerations, exposure, or other measures and is now more accurately termed "measures of effect" (EPA, 1998). The EPA has established three categories of measures:

(1) Measures of effect – Measureable changes in an attribute of an assessment endpoint or its surrogate in response to a stressor to which it is exposed (formerly measurement endpoints);

(2) Measures of exposure – Measures of stressor existence and movement in the environment and their contact or co-occurrence with the assessment endpoint; and

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(3) Measures of ecosystem and receptor characteristics – Measures of ecosystem characteristics that influence the behavior and location of entities selected as the assessment endpoint, the distribution of a stressor, and life-history characteristics of the assessment endpoint or its surrogate that may affect exposure or response to the stressor.

Measures of effect and measures of exposure will be used as the measurement endpoints to determine if adverse impacts are potentially occurring to the chosen assessment endpoints. The measure of exposure will be analytical measurements of the COPECs in sediment (bulk and pore water) and surface water samples. The measure of effect will be laboratory toxicity testing of Site samples of bulk sediment and surface water compared to laboratory control samples. Table 1 presents the guilds and their representative receptors, the BERA assessment endpoints, the ecological risk questions and testable hypotheses, the measurement endpoints, and the proposed toxisity tests. Deleted: and

2.5 UNCERTAINTIES AND ASSUMPTIONS

Risk assessments are designed to evaluate uncertainty, which is used to develop an investigation program that will result in the greatest decrease in uncertainty. The principal uncertainties inherent in all risk assessments are identified by the EPA as variability, uncertainty of the true value (i.e., measurement error), and data gaps (EPA, 1998). Throughout the risk assessment process, iterative steps are taken to reduce the uncertainty of the assessment, primarily through the collection of additional data until sufficient evidence has been collected that the inherent uncertainty is reduced to an acceptable level. The approach used in this risk assessment reduces uncertainty by focusing the investigation goals on the specific pathways and receptors identified in the Problem Formulation.

2.5.1 Uncertainties in the Conceptual Site Model

The conceptual model prepared for a site can be the source of significant uncertainty in a risk assessment due to a variety of factors, including lack of knowledge about ecosystem functions, a poor understanding of temporal and spatial parameter interaction, omission of stressors, or neglecting secondary effects (EPA, 1998). The uncertainties in the conceptual model prepared for the BERA have been reduced through the consideration of alternate models that account for a multitude of variables present at the Site.

2.5.2 Uncertainties in the Field Study

Sources of uncertainty in the field study are related to the accuracy of test measurements, the appropriateness of media, sampling, and testing protocols, and the proper selection of sampling

locations. Through strict adherence to the guidelines put forth in the Sampling and Analysis plan, uncertainty associated with the results of the field study will be sufficiently reduced such that the data is legally and scientifically defensible. Measures implemented to ensure this level of data quality include adherence to quality assurance guidelines designed to meet the project DQOs, inclusion of sampling and analysis methods that are well established and accepted in risk assessments, performance of the investigation by appropriately skilled project staff, and multiple checks on data quality prior to use in the risk assessment (i.e., third-party data validation, peer review). The data generated by the field study will represent the Site conditions during a specific time period and does not consider changes in COPEC concentrations, bioavailability, or COPEC sequestration due to temporal effects.

2.5.3 Assumptions

The principal assumption of the field study is that the lines of evidence generated by the field study will be sufficient to satisfy the assessment endpoints and that the data will be an adequate indicator of toxicity associated with COPECs present in the Site sediments. The uncertainty related to these assumptions is based on several factors, including the limitations of the test protocols in identifying effects caused by specific COPECs, toxicity effects due to environmentally modified or biotransformed compounds, and other variables that are not understood using currently available technology.

Other assumptions include:

- The results of the toxicity testing will be indicative of the effects of the COPECs;
- The pore water analytical results are representative of bioavailability;
- Bulk sediment analytical results coupled with TOC and AVS/SEM analyses are representative of bioavailability; and
- Differences in results between reference samples and target samples are a result of differences in chemical concentrations or bioavailability in the media.

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3.0 STUDY DESIGN

This section discusses the BERA study design. The study design involves selecting compounds, media, and organisms to be analyzed at the target and reference stations.

3.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) were established for the BERA through the Problem Formulation steps, which used the conceptual model to identify the assessment endpoints and risk questions identified in Table 1.

As noted in Section 1.0, the overall objective to be addressed by the BERA is to evaluate the specific contaminants, pathways, and receptors identified in the SLERA as warranting additional investigation. DQOs are based on the proposed end uses of data generated from sampling and analytical activities. DQOs are qualitative and quantitative statements that outline the decision-making process and specify the data required. DQOs are typically developed through a seven-step process (EPA, 2006). However, the DQO development process for ecological risk assessments is constrained by several factors, including the lack of specific criteria for ecological endpoints, the potential for multiple endpoints, and the use of weight-of-evidence evaluations of different measurement types (e.g., contaminant concentrations, bioassay tests). Given these limitations, the steps of the DQO process have been completed in a manner to produce qualitative and quantitative statements to develop an appropriate study design to address the needs of the BERA while still following the 7 steps of the DQO process.

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3.2 STATE THE PROBLEM

As noted in Section 1.0, the overall objective to be addressed by the BERA is to evaluate the specific contaminants, pathways, and receptors identified in the SLERA as warranting additional investigation. The objective of this Work Plan and SAP is to document the decisions and evaluations made during the Final BERA Problem Formulation and to identify the additional investigation activities needed to complete the evaluation of ecological risks.

The CSM presented in Section 2.1 of this Work Plan presents the primary release mechanisms, the secondary sources, the secondary release mechanisms, the exposure mediums, the potential

receptors, and the potential exposure pathways to be investigated. The CSM allows for planning to achieve the goals of the study by focusing the investigation.

The planning team members or stakeholders involved in the planning and execution of this SAP include decision makers (e.g., regulating agencies), the responsible parties, as well as those responsible for execution of the project (the contractors). Other people and organizations also may have concerns regarding how the BERA sampling investigation is ultimately executed. In such instances, the decision makers will represent these respective parties and consult with them regarding their concerns and issues.

This work plan proposes ninety (90) calendar days for sample collection, analysis, and data validation following receipt of EPA approval of the Final BERA Work Plan and SAP. This schedule consists of the following sequential activities: 1-2 weeks to organize the field effort; 2-3 weeks for sample collection; 6 weeks for laboratory analyses (including 28-day toxicity tests); and 3 weeks for data validation.

3.3 IDENTIFY THE GOALS OF THE STUDY

These objectives lead to the following three questions or goals of the study.

1. Does exposure to COPECs in sediment and surface water adversely affect the abundance, diversity, productivity and function of the benthic invertebrate community?
2. Does exposure to COPECs in sediment and surface water adversely affect the abundance, diversity, productivity and function of the fish community?

3.4 IDENTIFY INFORMATION INPUTS

To address the BERA objectives, an investigation program has been developed to use multiple lines of evidence including sediment toxicity testing, surface water toxicity testing, measures of COPEC bioavailability, and COPEC concentration data.

The investigation program includes bioassays of estuarine invertebrates coupled with chemical analyses of sediment, pore water, and surface water. The bioassays, chemical analyses, and

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determination of COPEC bioavailability represent three lines of evidence which will be used to support the conclusions of the BERA. The analyses have been selected to incorporate the media, pathways, and COPECs relevant to the assessment endpoints. Sampling, analysis, and data evaluation protocols have been selected to ensure that the data collected is scientifically defensible and applicable to the BERA objectives. Columbia Analytical Services (CAS) has been selected as the analytical laboratory of choice based upon their experience and expertise in analyzing samples in a marine environment, including acid volatile sulfides/simultaneoulsy extracted metals (AVS/SEM). (See Statement of Qualifications presented as Appendix A.)

Samples of bulk sediment for chemical analyses and bioassays, and pore water samples collected for chemical analyses, will be co-located and collected concurrently. Sample station locations have been selected based on the number and magnitude of COPECs with hazard quotients (HQs) greater than one (1) as shown on Table 2. Proposed sampling locations are provided on Figures 5 through 8, and the selection rationale provided in Section 3.5. It should be noted that collection of the amount of pore water required for PAH and pesticide analysis (minimum 2 liters [L] and preferably 4 L) may be difficult. Smaller sample size will result in increased detection limits.

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During the problem formulation step, hazard quotients greater than one for soil invertebrates were calculated for two compounds at soil sample location SB-204 in the North Area. The COPECs 4,4'-DDT and Aroclor-1254 had hazard quotients of 9 and 3, respectively, in a sample from this location. This sample location is located south of the former surface impoundments in an area that will be covered as part of the previously mentioned pending Removal Action for repair of the former surface impoundment cap. COPECs, 4,4'-DDT and Aroclor-1254, and the soil exposure pathway in this area were carried forward from the problem formulation; however, based on the pending Removal Action, soil samples are not included in the ecological investigation study design.¶
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<#>ANALYTICAL METHODS¶

3.4.1 Bioassays

Toxicity analyses will be performed on wetland and estuarine sediments and estuarine surface water using standard bioassay techniques. The goal of the bioassays will be to quantitatively assess ecological and biological impacts related to the COPECs found in sediment and surface water at the Site. Sediment bioassay tests will be performed using benthic invertebrates which are intimately associated with sediments due to their burrowing activity or consumption of sediment particulates. Sediment samples collected for bioassay analyses will be co-located and collected concurrently with sediment samples and sediment pore water collected for chemical analyses to ensure correlation among the data. Reference sediment samples will be collected from un-impacted areas to serve as controls for the bioassay analyses. Chronic bioassays utilizing both amphipods and polychaetes have been selected. The 28-day chronic bioassay using the amphipod *Leptocheirus plumulosus* and the 28-day chronic bioassay using the polychaete *Neanthes arenaceodentata* have been selected as the most appropriate method for evaluating the sediment toxicity at the Site.

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Leptocheirus plumulosus was selected because this species is representative of the common anthropods found in Texas gulf coast bay systems, and because long-term bioassay information is available. The *Leptocheirus* bioassay tests will use growth, mortality, and reproduction as measurement endpoints. *Neanthes arenaceodentata* were selected because they burrow and ingest sediment which represents significant exposure potential, and they represent one of the most abundant groups of benthic organisms found on the Texas gulf coast. The growth endpoint will be used for this study, with mortality data used only to assist in growth calculations. Both test organisms are sensitive to the Site COPECs, tolerant to a wide range of sediment and salinity conditions, and have been used extensively in bioassay tests.

Surface water toxicity at the Site will be evaluated through the use of a 7-day chronic bioassay analysis that measures survival and growth of *Mysidopsis bahia*. This bioassay was selected based on the appropriateness of the organism for site conditions and the sensitivity of the organism to the COPEC, copper. *Mysidopsis bahia* is more susceptible to exposure to COPECs than fish. Assessing for this receptor is therefore also protective for fish.

Test procedures for the bioassay analyses discussed in this section are provided in Appendix B.

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3.4.2 Chemical Analysis

Sediment chemical analysis

Sediments collected as part of the BERA investigation will be analyzed for Site COPECs, AVS/SEM, and Total Organic Carbon (TOC). According to the EPA guidance document *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (EPA, 2005a) concentrations of bulk (total dry weight basis) metals in sediment alone are typically not good measures of metal toxicity. The toxicity of metals can be estimated based on the bioavailable metal fraction, which can be measured in pore water and/or predicted based on the relative sediment concentrations of AVS/SEM and TOC. Both AVS and TOC are capable of sequestering and immobilizing a range of metals in sediment. AVS/SEM analysis will not be performed at Intracoastal Waterway sampling locations since no metal concentrations in Intracoastal Waterway sediments resulted in HQs greater than one. TOC will be measured at all sediment sample locations.

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Sediment pore water analysis

Sediment pore water will be analyzed for the COPECs indicated on Table 2 and will correspond to the COPECs of interest.

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Sediment physical properties analysis

The physical properties of Site sediments were evaluated as part of the RI/FS investigation conducted in 2006. The findings of the RI/FS (report pending) indicate consistent sediment grain size distribution throughout the investigation area. However, grain size will be evaluated at all sediment locations where AVS/SEM analysis is to be conducted.

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Surface water analysis

Surface water samples will be analyzed for dissolved copper and total acrolein using EPA methods 6010/6020 and 8260, respectively as indicated on Tables 2.

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3.4.3 Field Measurements

The following water quality parameters will be measured with a multi-probe sonde at all surface water and sediment sampling locations:

- pH;
- conductivity;
- temperature;
- salinity; and
- dissolved oxygen.

Field measurements of the redox potential (Eh) of sediments will be measured with a protable pH/Eh meter. In addition, field observations of the sediment will be documented, including the sediment texture and consistency; color; presence of biota or debris; and changes in sediment characteristics with depth.

3.5 DEFINE THE BOUNDARIES OF THE STUDY

During the problem formulation step, hazard quotients greater than one for soil invertebrates were calculated for two compounds at soil sample location SB-204 in the North Area. The COPECs

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4,4'-DDT and Aroclor-1254 had hazard quotients of 9 and 3, respectively, in a sample from this location. This sample location is located south of the former surface impoundments in an area that will be covered as part of the previously mentioned pending Removal Action for repair of the former surface impoundment cap. COPECs, 4,4'-DDT and Aroclor-1254, and the soil exposure pathway in this area were carried forward from the problem formulation; however, based on the pending Removal Action, soil samples are not included in the ecological investigation study design.

Sample locations, rationale, and analytical parameters are presented in Table 2. These locations were selected based upon the results of the Final SLERA (PBW, 2010a) and will serve to address the questions presented in Section 3.3

Sampling locations selected for the field study were chosen based on the results of the Final BERA Problem Formulation (URS, 2010), which identified the areas of the Site most likely to be at risk for ecological degradation. These locations represent a cross section of target COPECs and geographic settings across the areas. Sample locations were based on the magnitude of HQs, the number of analytes with HQs>1, and the overall number of samples in a specific area with these characteristics. Table 2 summarizes the proposed sample locations and analyses. Sediment sampling locations in the wetland area were selected to focus on locations where the HQ was greater than 3, but also contain a diversity of ecological screening results. For instance, the proposed location EWSED07 is targeted for PAHs but also contains endrin aldehyde and endrin ketone. Location EWSED03 is targeted for 4,4'-DDT but also contains high-molecukar weight polynuclear aromatic hydrocarbons (HPAHs). Location EWSED04 is targeted PAHs and did not have HQs> 1 for organochlorine pesticides.

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By this rationale and consistent with the similar characteristics between wetland and pond sediments and the shallow nature of the "Small Pond", a sediment sample from the "Small Pond" area was not included in the study design. Reference sample locations were selected to be representative of un-impacted Site conditions. Specific sample locations and rationale for selection are presented in Section 4.2 and summarized on Table 2. Areas of the Site that will be covered by the pending Removal Action to repair the former surface impoundments cap, including the area immediately south of the former surface impoundments, are not proposed for sampling.

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3.6 DEVELOP THE ANALYTICAL APPROACH

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The chemical data will be evaluated against the toxicity findings. The bioassay information will be evaluated against relevant ecological endpoints such as mortality, growth, and reproduction. The data will be evaluated to see if there is a correlation between chemical concentration and ecological endpoints. The chemical concentrations and ecological endpoints of the study data will be evaluated against the background/reference locations to determine if there is a difference between those locations and an influence of site related contaminants. If the site-related contaminants show persistent toxicity to the invertebrets indicating a significant risk to the community, then the risk managers would evaluate the pracatibility of Remedial Actions.

Data generated during the site investigation and analysis phase of the BERA will be used to characterize risk in relationship to the assessment endpoints established in the Problem Formulation. Risks to the assessment endpoints will be determined using a lines-of-evidence approach as described in *Guidelines for Ecological Risk Assessment* (EPA, 1998). During this process, each factor will be carefully examined and evaluated for its importance in characterizing risk assessment endpoints. This approach to risk analysis will rely on quantitative methods of evaluating the measures established for the investigation, including statistical analysis and comparison of data to media toxicity benchmark values.

Bioassay tests will be performed by an experienced and accredited laboratory with appropriate replicates and quality control measures to ensure strong statistical reliability and accuracy of test results. Quality control measures will be documented and later included as an appendix to the BERA. Bioassay test results will be compared to the results obtained from reference samples collected from the same media near the Site. Bioassay results will also be compared to laboratory control samples. The performance of the reference sample bioassays will be used as a control measure to distinguish between toxicological effects likely caused by Site COPECs or toxicological effects resulting from environmental factors (naturally occurring site conditions or laboratory environment). Following validation of the bioassay results and incorporation of reference sample impacts, bioassay data will be evaluated against other applicable lines of evidence, such as bioavailability and concurrently measured COPEC concentrations, to derive statements that are appropriate to address the assessment endpoints.

Chemical analysis of interstitial water and bulk sediment, as well as TOC and AVS/SEM, will be evaluated using established techniques (e.g., equilibrium partitioning) to determine the site-specific bioavailability of Site COPECs. The bioavailability characteristics of the COPECs will be further refined through the use of a literature search to ensure they are applied appropriately. COPEC bioavailability will be incorporated into the overall assessment of the investigation results and conclusions of risk characterization later in the BERA.

COPEC concentrations in environmental media (i.e., surface water, sediment) will be used to correlate bioassay and bioavailability results to toxicological effects, or lack thereof, of specific COPECs. Concentration data will be used to establish hazard quotient values necessary to evaluate ecological risk at the Site.

3.7 SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA

Acceptance criteria are presented in Section 4.

3.8 DEVELOP THE PLAN FOR OBTAINING DATA

This BERA Work Plan and SAP present the plan for obtaining data.

4.0 FIELD SAMPLING PLAN

4.1 SAMPLING TYPES AND OBJECTIVES

4.1.1 Sediment Sampling

Sediment sample stations were selected based on investigation requirements and the rationale presented in Section 3.4. A sample station map will be developed and the sample station coordinates will be determined before sampling is initiated. Sediment samples collected from each location for chemical analysis, pore water extraction, and toxicity testing will be collected at the same time (concurrent and co-located) and at the same depth interval.

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Sampling will be conducted from a boat, skiff, on foot, or other appropriate sampling platform as conditions indicate. Sampling in areas inaccessible by watercraft will be conducted by wading to the sample stations. A differential GPS receiver with sub-meter accuracy will be used to locate the stations and record actual coordinates, as detailed in Section 4.2. Sample station information, sample depth, and all other pertinent observations made during the study will be recorded on field data sheets. The following sections describe the basic sediment sampling procedures for the various techniques to be employed during the investigation.

Marsh and Wetland Sediment

Sediment will be collected from the intertidal marsh by approaching the sample site on foot, being careful not to impact the area to be sampled. The sample will be collected using a stainless steel scoop or spoon, and will be placed in a stainless steel bowl for homogenization. Aliquots of the sample will be removed from the bowl and placed in pre-cleaned labeled sample jars. Equipment used for sample collection, sub-sampling, and sample mixing (i.e., spoons, knives, scoops) will be stainless steel or Teflon®. Sediment samples collected for AVS/SEM analysis will be collected separately from the other samples (but at the same depth) and transported in a manner specified by the laboratory to reduce the likelihood of exposure to atmospheric conditions.

Intracoastal Waterway Sediment

Soft surficial sediment samples will be collected using an Ekman grab (or equivalent). The jaws of the sampler will be locked open and the sampler will be lowered to the bottom on a cable or

attached to a stainless steel pole. To prevent forward wake, the sampler will not be lowered faster than 0.3 m/sec as it nears the bottom. The sampler will be retrieved slowly to ensure proper jaw closure. The retrieved sampler will be lowered into a clean tub or tray, and secured in an upright position to prevent sediment movement. Collection of sediments using an Ekman or Ponar Grab device is also described in SOP-BESI-101 previously provided in the RI/FS Field Sampling Plan (PBW, 2006b).

A sediment sample will be acceptable if its depth is greater than 6 inches and the surface is relatively flat and undisturbed. If a sample is not acceptable it will be set aside (do not dump overboard), and a second sample will be collected. Unacceptable samples will be discharged overboard after an acceptable sample is collected.

Prior to removing sediments from the sampler, overlying water will be drained by gently tilting it. Care will be taken so that fine sediments are not decanted. A 0 to 6-inch sub-sample will be collected from the top of the closed sampler using a pre-cleaned spoon, scoop, or core tube. Sediment will be removed using pre-cleaned spoons and composited in pre-cleaned stainless steel bowls. Only the sediment from the center of the grab sampler (i.e., no sediment touching the walls of the sampler) will be used. Equipment used for sample collection, sub-sampling, and sample mixing (i.e., spoons, knives, scoops) will be stainless steel or Teflon®. Sediment samples collected for AVS/SEM analysis will be collected and transported in a manner specified by the laboratory to reduce the likelihood of exposure to atmospheric conditions.

Core Sampler

Samples of stiff sediment samples from the Intracoastal Waterway, Fresh Water Pond, and/or Small Pond may be collected using a piston-coring device if the grab sampler is not effective at collecting a representative sample. The coring device consists of a 3-inch diameter polycarbonate core tube attached to the end of an aluminum pole. The coring device will be manually driven into the sediment until firm resistance is detected. In the event that a single core does not provide the volume of material required by the analytical laboratory (approximately 1 liter), additional cores will be collected at that station to provide the required sediment. All cores samples from the same station will be combined and homogenized before aliquots are removed.

Sediment from 0-6 inches will be extruded into a stainless steel bowl and will be homogenized and placed in containers for other analyses.

The empty sampler (Ekman or core) will be rinsed and decontaminated following the procedures presented in Section 5.11. The sampler and associated equipment will be decontaminated before use, and between sample sites. In addition, the sampler will be rinsed with Site water before samples are collected.

4.1.2 Pore Water Sampling

Sediment pore water samples will be co-located with bulk sediment sample stations and will be collected concurrently with bulk sediment samples. Sediment samples collected for pore water analyses will be collected using a piston corer (SOP-BESI-102, RI/FS Field Sampling Plan, PBW, 2006b). Several 2 to 3 ft long core tubes will be collected at each station and the top six inches of sediment will be used for processing. Sediment samples will be kept in the core tube after sampling, capped, and transported to the processing area without disturbing the sediment. Processing will consist of centrifuging aliquots of the sediment samples until the pore water is separated from the sediment. The pore water is removed using a syringe and then filtered into a standard sample container. Due to the difficulty associated with pore water extraction and the limited volume of pore water generated, some detection limits may be elevated due to limited sample volumes.

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4.1.3 Surface Water Sampling

Surface water samples will be collected from one location north of the wetlands north of Marlin Avenue. The surface water sample will be collected from the water surface using a bailer, dip sampler or other discrete depth sampling equipment. Surface water sampling will be conducted in accordance with the SOP provided in the RI/FS Field Sampling Plan (SOP 10, Water Quality Sampling, PBW, 2006b).

4.2 SAMPLING LOCATIONS, TIMING, AND FREQUENCY

Proposed sampling locations are presented on Figures 5 through 8, and summarized on Table 2. The sample locations and rationales for selection are also presented on Table 2.

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Locating Proposed Sampling Stations

Sample stations will be located in the field using the coordinates extrapolated from proposed sample locations on the Site maps. A GPS receiver will be used to locate the proposed sampling sites in the field. The GPS unit will utilize real-time corrections to achieve the horizontal coordinates with sub-meter accuracy. Accuracy of the sample locations is important to mapping analytical results, so a relatively high degree of confidence is needed as to where each sample is collected, and if needed, the sample location can be reacquired for future efforts. The desired coordinates will be programmed into the GPS and the receiver can then guide the user to the desired coordinates. However, the proposed sampling locations may be modified in the field based on field conditions and professional judgment. If samples are collected from a sampling vessel, the sampling vessel will be secured at the station using a minimum of two anchors (one placed off the bow and one placed off the stern) to ensure the effects of crosswinds and/or tides are minimized.

Sampling Frequency and Timing

The investigation is planned as a one-time sampling event that will not require additional routine sampling events. The sampling event will be conducted within a reasonable timeframe following approval of the applicable project documents. Depending on the specific analytical methods chosen for the investigation, seasonal influences on bioavailability may be factored into the timing of the sampling event.

A ninety (90) calendar day schedule for sample collection, analysis, and data validation is proposed, based on the following sequential activities:

- 1-2 weeks to organize the field effort;
- 2-3 weeks for sample collection;
- 6 weeks for laboratory analysis (which includes 28-day toxicity tests); and
- 3 weeks for data validation.

4.3 SAMPLE DESIGNATION

The station and sample numbering system for the project has been designed to uniquely identify each sampling station and sample. This numbering system consists of the sample location identifier, depth (if applicable), and QA/QC identifier (if applicable). Sample locations will typically correspond to previous sampling locations that indicated an exceedance during the SLERA.

Sample locations will be designated by the investigation identifier "E" for "ecological risk assessment", followed by a Site location identifier i.e., "W" for wetland, followed by the sample type, i.e., SED, followed by the locations number (1, 2, 3…). Depth intervals in feet below grade will be assigned to sediment samples to designate the vertical sample location. Pore water samples will have the identifier "PW" appended to the sample ID. As an example, a sediment sample collected from 0 to 6 inches deep in the Intracoastal Waterway at sample station No. 1 will be designated as follows:

Sample ID: EIWSED01 (0-6)

A sample of pore water collected at this location would be assigned a sample ID of "EIWSED01PW".

Field quality control samples such as matrix spikes and matrix spike duplicates and field duplicates, which are detailed in the QAPP, will be designated with the primary sample identification and a quality control suffix as noted below.

Quality Control	Suffix Description	Sample Frequency
MS/MSD	Matrix spike/duplicate	1 per 20 samples per media
FD	Field duplicate	1 per 20 samples per media
EB	Equipment rinsate blank	1 per day/team
FB	Field blank	1 per day/team

To prevent misidentification of samples, labels will be affixed to each sample container. Information will be written on the label with a permanent marker. The labels will be sufficiently durable to remain legible even when wet and will contain the following information:

- Project identification number;
- Sampling station identification name;
- Name or initials of collector;
- Date and time of collection;
- Analysis required (if space on label allows); and
- Preservative inside bottle, if applicable.

4.4 SAMPLING EQUIPMENT AND PROCEDURES

4.4.1 Field Data, Equipment, and Instrument Calibration

Field data will primarily be direct observations, hand measurements, and direct-readings from field meters. These data will be tabulated and included in project reports or submittals, as appropriate. Appropriate field forms will be used to record field data collection activities.

Samples will be collected following the sampling procedures documented in this FSP. The equipment used to collect samples, time of sample collection, sample description, volume and number of containers, and preservatives added (if applicable) will be recorded on the appropriate field forms.

All field monitoring equipment will be calibrated at the beginning of each day before sample collection and when in use, if necessary. For each meter, recalibration requirements will be based on the manufacturer's guidelines and appropriate SOPs.

A Chain-of-Custody document will be initiated for the samples, and the appropriate information will be recorded on both the field-log sheet and chain document, as detailed in Section 5.4.

4.5 SAMPLE HANDLING

Samples will be preserved as indicated in Section 5 (QAPP), and stored, as necessary, on ice until shipped to the laboratory for analysis. To meet sample holding times, the samples will be packed in coolers and shipped as soon after collection as practical. Sample volumes, preservative, and holding time requirements are summarized on Table 3. Deleted: 5.

Samples will be placed in shipping coolers containing bagged, cubed ice immediately following collection. The samples will be grouped in the shipping cooler by the order in which the samples are collected. Samples to CAS will be shipped to the laboratory via an overnight courier service, generally on the day they are collected. The only exceptions to this procedure will be for samples collected after the courier service has picked up the shipment for the day and samples collected on a Sunday or holiday. In these instances, the samples will be shipped on the next business day. Specific protocols are included in PBW SOP-6: *Sample Custody, Packaging and Shipment*

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provided in the RI/FS Field Sampling Plan (PBW, 2006b). Samples to PBS&J may be transported directly to the lab or shipped via an overnight courier service, as described above.

Evidence of collection, shipment, and laboratory receipt must be documented on a Chain-of-Custody record by the signature of the individuals collecting, shipping and receiving each sample. A sample is considered in custody if it is:

- In a person's actual possession;
- In view, after being in physical possession;
- Sealed so that no one can tamper with it, after having been in physical custody; and/or
- In a secured area restricted to authorized personnel.

Chain-of-Custody Records will be used, by all personnel, to record the collection and shipment of all samples. The Chain-of-Custody Record may specify the analyses to be performed and should contain at least the following information:

- Name and address of originating location of samples;
- Name of laboratory where samples are sent;
- Any pertinent directions/instructions to laboratory;
- Sample type (e.g., aqueous);
- Listing of all sample bottles, size, identification, collection date and time, and preservative, if any, and type of analysis to be performed by the laboratory;
- Sample ID;
- Date and time of sample collection; and
- Signature of collector as relinquishing, with date/time.

The Chain-of-Custody procedure will be as follows:

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The field technician collecting the sample shall be responsible for initiating the Chain-of-Custody Record. The names of all members of the sampling team will be listed on the Chain-of-Custody Record. Samples can be grouped for shipment on a common form.

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Each time responsibility for custody of the samples changes, the receiving and relinquishing custodians will sign the record and note the date and time.

1) The Chain-of-Custody Record shall be sealed in a watertight container, placed in the shipping container, and the shipping container sealed prior to giving it to the carrier. The carrier waybill shall serve as an extension of the Chain-of-Custody Record between the final field custodian and receipt in the laboratory. The commercial carrier is not considered part of the COC chain and is not required to sign the COC.

2) Upon receipt in the laboratory, a designated individual shall open the shipping containers, measure and record cooler temperature, compare the contents with the Chain-of-Custody Record, and sign and date the record. Any discrepancies shall be noted on the Chain-of-Custody Record.

5) If discrepancies occur, the samples in question shall be segregated from normal sample storage and the project manager will be notified for clarification.

6) Chain-of-Custody Records, including waybills, if any, shall be maintained as part of the project records.

4.6 SAMPLE ANALYSIS

4.6.1 Proposed Laboratories

Bioassay

PBS&J
888 West Sam Houston Parkway South
Suite 110
Houston, TX 77042-1917
713-977-1500

Chemical Analysis

Columbia Analytical Services
1317 South 13th Avenue
Kelso, Washington 98626
360-577-7222

Deleted: Aquatic Bioassay & Consulting Laboratories, Inc. (ABC)¶
29 North Olive Street¶
Ventura, California¶
(805) 643-5621¶
¶
AVS/SEM¶
TestAmerica¶
301 Alpha Drive .
Pittsburgh, PA 15238-2907 .
(412) 963-7058¶
¶

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The laboratories chosen to provide analytical services for the BERA were selected based on historical performance and areas of technical expertise related to ecological risk assessments. SOPs for test methods provided by the bioassay laboratory are provided in Appendix B. A Statement of Qualifications and Quality Assurance/Quality Control Manual for PBS&J and CAS are provided in Appendix C.

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4.6.2 Chemistry Analysis Methods

Chemistry analyses will be conducted according to established EPA or ASTM methods. The analytical methods selected for use during this investigation are presented in Table 4 and listed below:

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- Metals – EPA Method 6010/6020
- PAHs and hexachlorobenzene – EPA Method 8270C
- Organochlorine Pesticides – EPA Method 8081
- TOC – SW846 Method 9060
- AVS/SEM – EPA Draft Analytical Method EPA/821/R-91/100
- Grain Size - ASTM D422

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4.6.3 Toxicity Testing Methods

Bioassay tests were selected based on the appropriateness of the test organism relative to the physical characteristics of the Site (salinity, sediment grain size, etc.) and sensitivity to the Site COPECs. The specific species were selected because of their interaction with sediment (burrowing and ingestion), they are representative of one of the most abundant groups of benthic organisms found in Texas bays (polychaetes), they represent one of the most abundant groups of crustaceans found in Texas bays (amphipods), and they have been used extensively in similar ecological assessments. Toxicity tests selected for use in the ecological risk assessment are provided on Table 4 and listed below. The test procedures for bioassay tests are provided in the SOPS included in Appendix B.

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Sediment

- 28d chronic (growth, survival, reproduction) bioassay using *Leptocheirus plumulosus; and*
- 28d chronic (growth and survival) bioassay using *Neanthes arenaceodentata*

Surface water

- 7d chronic (growth and survival) bioassay using *Mysidopsis bahia.*

4.7 CONTINGENCIES

This section describes contingency procedures to be used if a portion (or portions) of the steps described in this Work Plan cannot be performed. Contingency planning includes informing the EPA of problems encountered and alternate actions being considered. The EPA will also be notified of other problems that may be encountered during sample collection and transport, such as sample loss or container breakage.

The type of contingency procedures required (e.g., departures or deviations) will be recorded on field sheets. EPA will be informed of all deviations, considered one-time occurrences, as soon as is practical.

5.0 QUALITY ASSURANCE PROJECT PLAN

5.1 PROJECT DESCRIPTION

This QAPP has been prepared for the BERA at the Gulfco Marine Maintenance Site. The BERA Work Plan that includes this QAPP describes the project background and investigation objectives, including the site description and history, the project objectives, and the sample network design and rationale. The FSP describes procedures to be implemented in the field. Investigation specific procedures and protocols for sample collection, chain-of-custody, sample handling, sample analysis, and report preparation are included in this QAPP or by reference to the previously submitted Sampling and Analysis Plan (SAP) included in the RI/FS Work Plan prepared for the Site (PBW, 2006c). The QAPP is organized in accordance with basic EPA guidelines for the preparation of QAPPs. Laboratory Quality Manuals are presented in Appendix C.

The goal of the QAPP is to assure that the data collected meet the project objectives established in Section 3.1. All QA/QC procedures will be in accordance with applicable professional standards, government regulations and guidelines, and specific project goals and requirements.

5.2 QA/QC ORGANIZATION AND RESPONSIBILITIES

Respondent's Project Coordinator

The Respondent's Project Coordinator will direct and supervise all BERA work. The Project Manager's responsibilities will be to review all BERA project work to ensure that it meets the specific project goals, meets technical standards, and is in accordance with the objectives and procedures discussed herein.

BERA Investigation Manager

The BERA Investigation Manager will direct and supervise all BERA work. The BERA Investigation Manager's responsibilities will be to review all BERA project work to ensure that it meets the specific project goals, meets technical standards, and is in accordance with the objectives and procedures discussed herein.

QA Manager

The QA Manager will remain independent of direct involvement in day-to-day operations, but will have direct access to staff, as necessary, to resolve any QA issues. The QA Manager has sufficient authority to stop work on the investigation as deemed necessary in the event of serious QA/QC issues. Specific functions and duties include:

- Performing QA audits on various phases of the project's operations, as necessary;
- Reviewing and approving this QAPP and other QA plans and procedures;
- Performing validation of data collected relative to risk assessment activities and this QAPP; and
- Providing QA technical assistance to project staff.

The QA Manager will notify the Project Coordinator of particular circumstances that may adversely affect the quality of data and ensure implementation of corrective actions needed to resolve nonconformances noted during assessments.

Field Supervisor

The Field Supervisor will be responsible for all aspects of field work performed as part of a specific risk assessment activity. Different project subtasks or activities may have different Field Supervisors. Duties of the Field Supervisor will include:

- Maintaining field records;
- Continually surveying the Site for potential work hazards and relate any new information to site personnel at the Tailgate Safety Meeting held each day prior to beginning field activities; Deleted: .
- Ensuring that field personnel are properly trained, equipped, and familiar with Standard Operating Procedures and the Health and Safety Plan;
- Overseeing sample collection, handling and shipping; ensuring proper functioning of field equipment; and
- Informing the laboratory when samples are shipped to the lab and verifying samples arrived at the lab.

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The primary duty of the Field Supervisor is to ensure that the field sampling is performed in accordance with the project sampling plans and this QAPP. The Field Supervisor will also require that appropriate personal protective equipment will be worn and disposed of according to the Health and Safety Plan provided in the RI/FS SAP prepared for the Site (PBW, 2006b). In addition, the Field Supervisor may be responsible for preparing monitoring reports for review by the Project Manager.

Laboratory QA Manager

The laboratory QA Manager will have overall responsibility for data generated in the laboratory. The laboratory QA Manager will be independent of the laboratory production responsibilities, but will communicate data issues through the Project Manager. In addition, the laboratory QA Manager will

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- Monitor the day-to-day quality of the laboratory data;
- Maintain and review all quality control data;
- Conduct internal performance and system audits to ensure compliance with laboratory protocols.;
- Review and maintain updated Standard Operating Procedures (SOPs); and
- Prepare Performance Evaluation reports and corrective action reports.

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Deleted: <#>DATA QUALITY OBJECTIVES¶
¶
Data quality objectives (DQOs) are qualitative and quantitative statements derived from the outputs of each step of the DQO process. The DQO process is a series of planning steps based on the scientific method that is designed to ensure that the type, quantity and quality of environmental data used in decision-making are appropriate for the intended application (EPA, 2000).¶
¶
The DQO development process for the BERA was completed through the Problem Formulation and Study Design steps (EPA, 1997), and consisted of:¶
¶
<#>Clarifying the study's objective and defining the most appropriate types of data to collect;¶
<#>Determine the proper field conditions under which the study should be conducted; and ¶
<#>Specifying acceptable levels of uncertainty as the basis for establishing the quantity and quality of data needed to support risk management decisions.¶
¶
BASED ON THE RESULTS OF THE PROBLEM FORMULATION, MEASUREMENT ENDPOINTS, QUANTITY AND QUALITY OF DATA, AND ACCEPTABLE LEVELS OF DECISION ERROR WERE ESTABLISHED AS PRESENTED IN SECTION 3.0.

5.3 PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESS, COMPARABILITY AND SENSITIVITY

Performance objectives have been established for each of the Data Quality Indicators (Precision, Accuracy, Completeness, Representativeness, and Comparability) as defined below.

5.3.1 Precision

Precision is a measure of the reproducibility between two or more measurements of the same characteristic (i.e., analyte, parameter) under the same or similar conditions. Determining the agreement among replicate measurements of the same sample assesses the precision of the analytical procedure; combined precision of sampling and analysis procedures is assessed from the agreement between measurements of field duplicate samples. The relative percent difference

(RPD) in the results will be computed for each duplicate pair. The RPD is defined as 100 times the absolute value of the difference (range) of each duplicate set, divided by the average value (mean) of the set:

$$RPD = \frac{ABS(\text{primary sample result} - \text{duplicate sample result})}{\text{average of primary and duplicate sample result}} \times 100$$

Field Precision Objectives

Precision of sampling and analysis procedures will be assessed through the collection of field duplicate samples. Data for duplicate analyses will be evaluated only if both of the samples in the duplicate pair have a concentration greater than the method quantitation limit (MQL). It is noted here that natural variation in some of the matrices will affect how closely these goals are met; that is, if variation is high, then these goals are unrealistic. Consequently, RPD results from field duplicates will not be used as a basis for invalidating any analytical data. The RPD goals for water field duplicates are RPD ≤30% and for sediment are RPD ≤50%.

Laboratory Precision Objectives

Precision of the analytical procedure will be assessed through duplicate analyses of laboratory QC and field samples. Data for duplicate analyses will be evaluated only if both of the samples in the duplicate pair have a concentration greater than the method quantitation limit (MQL). Precision goals are presented in Table 5.

5.3.2 Accuracy

Accuracy is a measure of the bias in terms of the degree of agreement between an observed value (i.e., sample result) and the accepted reference or true value. Accuracy is expressed as the percent recovery of spiked analytes. The equations used to calculate percent recovery is:

$$\% \text{ Recovery} = \frac{\text{measured amount}}{\text{known amount}} \times 100$$

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Laboratory blank samples and field blanks will also be used to quantify the effect of sample contamination on overall data accuracy.

Field Accuracy Objectives

The potential for field contamination will be assessed through collection of equipment blanks (when non-dedicated sampling equipment is used) and trip blanks (as needed) and adherence to all sample handling, preservation and holding time requirements.

Laboratory Accuracy Objectives

Laboratory accuracy will be evaluated by the analysis of laboratory control samples (LCS), matrix spike (MS) samples and surrogate spikes, with results expressed as a percentage recovery measured relative to the true (known) concentration. In addition, laboratory preparation blank results will be used to measure any contamination introduced during the analytical process. The objectives for minimizing the effect of laboratory contamination on sample accuracy are concentrations less than the MQL in all blank samples. LCS and MS acceptance criteria are presented in Table 5. Data will not be rejected based upon MS recoveries.

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5.3.3 Completeness

Completeness is the percentage of valid measurements or data points obtained, as a proportion of the number of measurements or data points planned for the project. Completeness is affected by such factors as sample bottle breakage and acceptance/rejection of analytical results. Completeness will be re-calculated and presented in each validation checklist. If completeness approaches the established goal (within 2-3%), corrective action will be instituted as described in Section 5.9. The completeness goal for sediment samples is sample level is 90% and for water samples is 95%.

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5.3.4 Representativeness

Representativeness is a qualitative objective, defined as the degree to which data accurately and precisely represents the characteristic of a population, the parameter variations at a sampling point, the process condition, or an environmental condition within a defined spatial and/or temporal boundary.

Field Representativeness Objectives

Field representativeness is achieved by collecting a sufficient number of unbiased (representative) samples and implementing a QC program for sample collection and handling prior to analyses. The sampling approaches developed for this project will provide for samples that are representative of site conditions. Any equipment blank and field blank results will also be evaluated to ensure that analytical results are representative of sample concentrations.

Laboratory Representativeness Objectives

Representativeness in the laboratory is ensured by using the proper analytical procedures, appropriate sample handling and preparation methods, meeting sample holding times and analyzing and assessing duplicate samples.

5.3.5 Comparability

Comparability is the confidence with which one data set can be compared to another.

Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the standard field protocols in the FSP are consistently followed and that the sampling techniques specified in the sampling plan are consistently used.

Measures to Ensure Comparability of Laboratory Data

Planned analytical data will be comparable when the sampling and analytical methods described in the FSP and in this QAPP are used for sample collection and laboratory analysis. This goal is achieved through the consistent use of standard techniques to collect and analyze representative samples. Results of sample analyses will be consistently reported in appropriate units. Comparability is also dependent upon the laboratory obtaining the QA objectives for accuracy and precision. All data that meet the QA objectives described in this document and are considered usable will be considered comparable data.

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5.3.6 Sensitivity

Analytical methods have been selected based upon the sensitivity of the method detection limits. To ensure that the data are usable, the method must be able to meet the ecological endpoints. A comparison of laboratory method detection limits and ecological endpoints is presented in Table 6.

5.4 SAMPLING PROCEDURES

Project sampling processes were designed to obtain information necessary to address those data needs described in the CSM, and identified during the BERA Problem Formulation step. Field sampling procedures employed during the ecological risk assessment will be consistent throughout the project, thus providing data representative of site conditions, comparability with analytical considerations, practicality, and simplicity. Procedures for all aspects of collection, preservation, and transport of samples are provided in the FSP.

5.4.1 Sampling Methods

Sampling methods are described in Section 4.0 of this Work Plan. SOPs for these methods are provided in Appendix A of the RI/FS FSP (PBW, 2006b).

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Sample Volume, Containers, and Preservation

The sample volume, container and preservation requirements will be in accordance with requirements for the specific analytical methods. This information is provided in Table 3.

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5.4.2 Sampling Quality Control Requirements and Acceptability Criteria

Field Duplicate

Field duplicates will be collected for chemical analyses at the frequency of one per 20 field samples collected or at least one per sampling day (excludes bioassay samples). A field duplicate is defined as a second sample (or measurement) from the same location, collected in immediate succession, using identical techniques. The duplicate sample will be collected from the same homogenized composite material as the sample it is duplicating. Duplicate samples are sealed, handled, stored, shipped, and analyzed in the same manner as the primary sample. Precision of

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duplicate results is expressed by the RPD between the results of the two samples. Precision goals for sediment samples are RPD ≤50% and for aqueous samples the goal is an RPD ≤30%.

Field Splits

Field splits are not required for any of the activities, but may be requested by the EPA. A field split is collected in the same manner as a field duplicate. Precision goals for sediment samples are RPD ≤50% and for aqueous samples the goal is an RPD ≤30%.

Equipment Blanks

Equipment blanks (rinsate) blanks may be collected when sampling requires the re-use of non-dedicated equipment. If required, equipment blanks will be collected once per day, from decontaminated sampling equipment and analyzed for the COPECs of interest. When possible, rinsate blanks will be collected from the final rinse water of non-dedicated decontaminated equipment to assess the effectiveness of the cleaning and decontamination procedure. Rinsate blanks will be used to qualify the data and may be used to invalidate the sample results.

Trip Blanks

Trip blanks are typically included in sample shipping containers to evaluate the potential for contamination from VOCs during sample transport. Since trip blanks are used only when samples are collected for volatile organic compounds analyses, not all activities will require trip blanks. Trip blanks will be used to qualify the data and may be used to invalidate the sample results.

5.4.3 Field Sample Handling and Custody

Chain-of-Custody (COC)

Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, analysis, and disposal.

A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. The COC form is used to document sample handling during transfer from

the field to the laboratory and among contractors. The list of items below should be included on the COC form.

- Site identification
- Sample identification
- Date and time of collection
- Sample matrix
- Container type
- Number of containers
- Preservative used
- Notation if the sample was filtered
- Analyses required
- Name and signature of collector(s)
- Custody transfer signatures and dates and time of transfer
- Name of laboratory admitting the samples
- Bill of lading (if applicable)

Sample Labeling

Sample labels are completed with an indelible, waterproof marker. Label information includes the sample identification number, the date and time of sampling and sample type. The sample identification numbering system for the project has been designed to uniquely identify each sampling station and sample. This numbering system consists of a sequential sample location identifier, depth (if applicable), and QA/QC identifier (if applicable), as detailed in the FSP.

Sample Handling

Sample handling procedures for each activity and type of sample are described in the FSP.

Failures in Chain of Custody and Corrective Action

All failures associated with COC procedures are immediately reported to the person who originally signed the COC, typically the Field Supervisor. These include such items as delays in transfer, resulting in holding time violations; violations of sample preservation requirements; incomplete documentation, including signatures; possible tampering of samples; broken or spilled

samples, etc. The Project Manager or Field Supervisor, in consultation with the QA Manager, will determine if the procedural violation may have compromised the validity of the resulting data. Any failures that have reasonable potential to compromise data quality will invalidate data, and the sampling event should be repeated. The resolution of the situation will be reported to the Project Coordinator. Corrective action reports will be maintained by the QA Manager.

5.4.4 Laboratory Sample Handling and Custody

Sample Receipt

Upon receipt by the laboratory, sample integrity will be inspected and documented on the COC or associated document (i.e., a sample receipt report or similar document). Information to be noted on the COC includes: name of person inspecting cooler, integrity of custody seals, sample cooler temperature, evidence of preservation, physical condition of sample container, and airbill number. The COCs will be reviewed for completeness. If any sample integrity or sample ID problems or discrepancies are found, the Field Supervisor or Project Manager will be notified immediately. A COC addendum or sample receipt report may be used to document the corrective actions used to address any COC discrepancies. If an addendum is not used, corrective actions used to correct COC discrepancies must be recorded directly on the COC. Samples will be stored in a specially designated area that is clean, dry, and refrigerated (if needed).

Sample Labeling

The field sample number will be recorded on the sample inventory, the COC, and on the sample label. All samples will be assigned discrete sample identification numbers (sample control numbers) upon receipt by the laboratory. The laboratory sample control number will remain the same throughout the analysis and data entry procedures. Final results will be reported with both the field sample ID and the laboratory sample control number.

Sample Custody

The laboratory will be responsible for maintaining an accurate custody record for each sample in the lab. Records will be maintained to document the date and time the sample is checked out of sample storage for analysis and the date and time at which the sample is returned. The Laboratory Project Manager or laboratory contact will be responsible for supplying the Field Supervisor (or their designee) with a sample acknowledgment form within 24 hours of sample

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receipt. This form will provide sample receipt information, sample log-in information, and the laboratory project number for the samples. A completed, signed COC will be sent by the laboratory to the Project Manager with the final data report.

5.5 ANALYTICAL PROCEDURES

Analytical methods for investigation activities are presented in Section 4.6 of this Work Plan. The test methods selected as part of this investigation program are standard EPA or ASTM procedures.

Deleted: SOPs for laboratory analyses included in this investigation are provided in Appendix A.

Detailed laboratory QC requirements are contained within each individual method SOP. The minimum requirements for the QC samples are outlined below. Laboratory QC sample results are reported with the data report.

Laboratory Duplicates, Matrix Spikes, and Matrix Spike Duplicates

Duplicate analysis is performed as a measurement of precision on the analytical process. Laboratory duplicates are independently repeated measurements of the same sample, which are performed by the same analyst and under the same conditions. The sample is split in the laboratory and each fraction is carried through all stages of preparation and analysis. The RPD is calculated from the two sample results. The duplicate procedure is performed at least once per 20 samples for chemical analyses which do not include matrix spike/matrix spike duplicates (MS/MSDs).

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MSs are prepared by adding a known amount of each target analyte (or a subset thereof) to a known amount of sample. The MS is added at the beginning of the procedure and is carried through the entire measurement process. The sample itself (without an MS) is also carried through the analytical process. In order to produce reliable recovery results, the spike level must be similar to the sample concentration. Because the MSs are prepared and analyzed at the same time as the sample, only a reasonable estimate of the spike level can be made. Where samples are collected in field areas that are expected to have high concentrations, they will be identified for the laboratory, and corresponding spike levels can be used. The amount of the spike should be at least four times the amount in the unspiked sample.

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The spike recovery measures the effects of interferences caused by the sample matrix in the analytical process. The MS recovery is calculated as follows:

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$$\% \text{ Recovery} = \frac{\text{spiked sample result} - \text{sample result}}{\text{theoretical spike concentration}} \times 100$$

For chemical analyses, the matrix spike procedure is performed once per batch of 20 samples. The MS is prepared and analyzed in duplicate and the second spike is called the MSD. This procedure evaluates the precision associated with the procedure and the analyst performing the procedure and is calculated as a RPD as described above.

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If a site sample is to be used as an MS/MSD, the sample to be used shall be designated on the COC. The MS/MSD is used to document the bias of a method due to sample matrix, not to control the analytical process and thus laboratory corrective action is not instituted based on MS/MSD results.

Laboratory Control Standard (LCS) and Laboratory Control Standard Duplicates (LCSDs)

The laboratory control sample (LCS) is an aliquot of a solid or aqueous certified reference material containing a known amount of each target analyte being measured. The LCS is treated like a field sample from the beginning of the procedure and is carried through the entire measurement process. The amount of the spike should be at a level less than or equal to the midpoint of the calibration curve for each analyte. For chemical analyses, the LCS is analyzed once per batch of 20 samples.

The percent recovery of the target analytes in the LCS assists in determining whether the procedure is in control. It is further used to evaluate the accuracy and bias of all or a portion of the measurement process. If insufficient quantity of sample is provided to perform a matrix spike and matrix spike duplicate, a duplicate LCS (LCSD) is prepared and analyzed and the RPD is calculated as described previously.

Detectability Check Sample

For chemical analyses, the laboratory should routinely check the instrument MDL to verify the laboratory's ability to reliably detect the parameter at the MDL that is used for reporting detected

results and calculation of non-detected results. The detectability check standard should be routinely analyzed and the results maintained on file with the MDL data.

Method Blank

The method blank is analyte-free water or solid material that is processed simultaneously with and under the same conditions as the samples. For chemical analyses, the method blank is analyzed once per batch of 20 samples to demonstrate that the analytical system itself is not contaminated with the analyte(s) being measured. The method blank results should be below the Method Quantitation Limit or corrective action must be taken. No qualification is warranted if a sample result from the sample group is greater than or equal to five times the associated blank concentration. Analytical results less than five times the associated blank concentration are qualified as non-detected.

Negative Control

A control sediment is one that is essentially free of contaminants and is used routinely to assess the acceptability of a bioassay test; it is not necessarily collected near the site of concern. A control sediment provides a measure of test acceptability, evidence of test organism health, and a basis for interpreting data obtained from the test sediments. Any study in which organisms in the negative control do not meet performance criteria must be considered questionable. The negative control is included in each batch of bioassay test samples.

Positive Control (Reference Toxicant)

A reference-toxicity test is one conducted with reagent-grade reference chemical to assess the sensitivity of the bioassay test organisms response to a toxicant challenge. Deviations outside an established normal range (±2 SD, 95% confidence limits) may indicate a change in the sensitivity of the test organism population. Reference-toxicity tests are most often performed in the absence of sediment and are performed at least once every six months.

Additional Method Specific QC Requirements

Additional QC samples may be run (e.g., continuing calibration samples), as specified in the method SOPs. The requirements for these samples, their acceptance criteria, and corrective action are method-specific.

Failures in Quality Control and Corrective Action

All qualified data are evaluated by the Project Manager, in consultation with the QA Manager. Since the differences between field duplicate sample results are used to assess the entire sampling process, including environmental variability, the arbitrary rejection of results based on pre-determined limits is not practical. Therefore, the professional judgment of the Project Manager and QA Manager will be relied upon in evaluating results. Rejecting sample results based on wide variability is a possibility. Field blank values exceeding the acceptability criteria may automatically invalidate the sample, especially in cases where high blanks may be indicative of contamination that causes a result to exceed the standard. Field duplicate excursions will be noted. Equipment blank results are also scrutinized very closely. Corrective action will involve identification of the cause of the failure where possible. Response actions may include re-analysis of questionable samples. In some cases, a site may have to be re-sampled to achieve project goals.

Laboratory measurement quality control failures are evaluated by the Laboratory Project Manager and findings reported to the Project Manager.

Standards Traceability

All standards used in the laboratory are traceable to certified reference materials. Standards preparation is fully documented and maintained in a standards log book. Each document includes information concerning the standard identification, starting materials, including concentration, amount used and lot number, date prepared, expiration date and preparer's initials or signature. The reagent bottle is labeled in a way that traces the reagent back to the preparation.

Failures in Measurement Systems and Corrective Actions

In many cases, the field technician or lab analyst will be able to correct problems. If the problem is resolved by the field technician or lab analyst, he/she will document the problem on the field data sheet or laboratory record and complete the analysis. If the problem is not resolvable, then it is conveyed to the Laboratory Project Manager, who will make the determination and notify the QA Manager. If the analytical system failures may compromise the sample results, the resulting

data will not be reported. The nature and disposition of the problem is reported on the data report, which is sent to the Project Manager.

5.6 PREVENTIVE MAINTENANCE

5.6.1 Field Instrument Preventive Maintenance

Field instruments are checked and calibrated prior to beginning the field program and daily before use to verify that instruments are in good working order. Routine preventive maintenance procedures are specified in the relevant operation manuals. Additional details on the field equipment to be used in this project are provided in applicable procedures specified in the Field Sampling Plan.

5.6.2 Laboratory Instrument Routine Maintenance Activities

As part of the laboratory QA/QC program, a routine preventive maintenance program will be conducted by the laboratories to minimize the occurrence of instrument failure or other system malfunction. The laboratory workload will be scheduled to accommodate planned downtime required to complete routine maintenance procedures. Trained operators will complete routine maintenance procedures (e.g., changing oven fans, replacing electronic control boards, changing vacuum pump oil, cleaning, etc.) for GC/MS instruments. An inventory of spare parts will be maintained to facilitate timely repair of instruments and minimize downtime.

Records of preventive maintenance activities for each piece of equipment will be maintained in Calibration and Maintenance log books assigned to that instrument. Preventive maintenance performed during the project will be noted in the field logbook and the instrument Calibration and Maintenance log book.

5.6.3 Inspection/Acceptance Requirements for Supplies and Consumables

Supplies and spare parts should be maintained for both field and laboratory instruments to assure timely completion of sample screening and analysis. For field work, critical spare parts such as batteries will be kept on-site to reduce downtime. Backup instruments and equipment should be available on-site or within 1 day shipment to avoid delays in the field schedule.

5.7 DATA MANAGEMENT AND REPORTING

Data management provides a process for tracing the path of the data from their generation in the field or laboratory to their final use or storage. The following elements are included in this process: recording, validation, transformation, transmittal, reduction, analysis, tracking, and storage and retrieval.

Data Recording

Sample collection will be documented and tracked using field log forms, field logbook entries, and Chain-of-Custody Records. Field personnel will complete these forms, which then will be reviewed for correctness and completeness by the Field Supervisor. Copies of these forms will be maintained in the project files.

Data Transformation

Since data will be collected and/or reported using proper units according to this QAPP, no data transformation is expected. If data transformation is necessary, the transformation procedures will be added to this QAPP.

Data Transmittal

The Field Supervisor will be responsible for assuring that field data are entered onto the appropriate field data forms, and will report any problems to the Project Manager. Field Supervisors will submit the complete field data forms to the Project Manager for review and error checking.

Field Supervisors will also ensure that all samples collected in the field are submitted to the laboratory according to the methods outlined in this QAPP or the FSP. The laboratory will submit to the Project Manager or Field Supervisor the analytical data results in their standard hard-copy format (including raw data format) and in an electronic data deliverable (EDD) format prior to sending the final data report in PDF to the Project Manager. The EDD shall be in space or comma-delimitated ASCII format or in Excel spreadsheet format that will allow for easy integration into a digital database.

Once reviewed by the Project Manager or Field Supervisor for obvious transcription or reporting errors, the final data report in both hard-copy and EDD formats will be transmitted and ready for validation by the QA Manager. Following data validation, any data qualifiers added to data during the validation process will be imported into the project database. Entry or upload of EDDs and data qualifiers into the project database will be completed by a designee of the Project Manager. The data and qualifiers will be initially verified by the individual entering the data. Upon completion of the initial verification step, a report will be generated of the data and verified by the Project Manager against the original data. Only final versions of electronic data will be entered into the database. All electronic data will be verified before and after incorporation into the database against the hard copy reports that accompany the data.

All qualified data will be included with the data packages during all subsequent data transmittal processes. The final hard copy data validation checklists will be included with the data in the final BERA report document.

All field forms and lab data will be organized and stored by sample location allowing for easy access if needed. Data can be transferred electronically either on disc, CD, tape or as an email attachment.

Data Storage and Retrieval

PBW's Project Manager is responsible for project data storage and retrieval. Laboratory data that are stored electronically will be archived electronically, and where printed as part of the paper data report package, will also be archived in paper form. Both the electronic data and hard copies will be maintained in PBW's Round Rock, TX office. In general, all records and data must be retained for a period of 10 years following commencement of construction or of any remedial action which is selected following completion of the RI/FS, per Section XX, Paragraph 79 of the UAO.

5.7.1 Data Review: Verification, Validation, and Integrity

For the purpose of this document, verification means the processes taken to determine compliance of data with project requirements, including documentation and technical criteria. Validation means those processes taken independently of the data-generation processes to determine the

usability of data for its intended use(s). Integrity means the processes taken to assure that no falsified data will be reported.

All data obtained from field and laboratory measurements will be reviewed and verified for conformance to project requirements, and then validated against the project objectives. Data supported by appropriate quality control results that meet the project objectives defined for this project will be considered acceptable without qualification. Data associated with quality control results that do not meet the project objectives defined for this project will be assigned appropriate qualifiers reflecting the potential impact on data usability. Analytical data will be considered usable unless rejected during the validation process.

The Field Supervisor is responsible for ensuring that field data are properly reviewed and verified for integrity by reviewing field equipment calibration records and verifying proper field procedures. The Analytical Lab Project Manager is responsible for ensuring that laboratory data are scientifically valid, defensible, of acceptable precision and accuracy, and reviewed for integrity and indicates this by signing the data package Narrative. The QA Manager will be responsible for ensuring that all laboratory data are properly reviewed and verified, and submitted in the required format to the project database. The QA Manager is responsible for validating the laboratory data and documenting the review. Finally, the Project Manager, with the concurrence of the QA Manager, is responsible for verifying that all data to be reported meet the objectives of the project and are suitable for reporting.

Verification and Validation Methods

All data will be verified to ensure they are representative of the samples analyzed and locations where measurements were made, and that the sample results and associated quality control data conform to project specifications. The staff and management of the respective field, laboratory, and data management tasks are responsible for the integrity, validation and verification of the data each task generates or handles throughout each process. The field and laboratory tasks ensure the verification of raw data, electronically generated data, and information on COC forms and hard copy output from instruments. The Analytical Lab Project Manager will document the review of the reported data per the laboratory's QA Plan.

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Verification, validation and integrity review of all laboratory data will be performed or supervised by the QA Manager. The data to be verified are evaluated against project specifications (and are checked for errors, especially errors in transcription, calculations, and data input. The QA Manager will validate all reported laboratory data in accordance with the project Data Validation Standard Operating Procedure found in Appendix F of the RI/FS QAPP (PBW, 2006c). All laboratory data will be validated using a Level III data review. For critical samples, a Level IV review may be instituted. The validation will be documented on the Validation Checklist included in the SOPs and data qualifiers will be added to the database as appropriate. The SOPs include guidelines for applying data qualifiers. Generally, data will be rejected for use if the holding time is grossly exceeded or the QC data indicates an extremely low bias (<10% true value) in the measurement.

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Potential outliers are identified by the QA Manager and Project Manager by examining results for unreasonable data, or identified using computer-based statistical software. If a question arises or an error or potential outlier is identified, the Field Supervisor or the Analytical Lab Project Manager responsible for generating the data is contacted to resolve the issue. Issues that can be corrected are corrected and documented electronically or by initialing and dating the associated paperwork. If an issue cannot be corrected, the QA Manager and/or the Project Manager will determine the appropriate course of action, or the data associated with the issue are rejected.

The Project Manager and QA Manager are each responsible for validating that the verified data are scientifically valid, defensible, of known precision, accuracy, integrity, meet the project objectives of the project, and are reportable. One element of the validation process involves evaluating the data again for anomalies. The QA Manager or Project Manager may designate other experts familiar with the project to perform this evaluation. Any suspected errors or anomalous data must be addressed by the manager of the task associated with the data before data validation can be completed.

5.8 SYSTEMS AND PERFORMANCE AUDITS

Performance and system audits may be conducted to verify that sampling and analysis are performed in accordance with applicable SOPs specified for field and laboratory activities. The audits of field and laboratory activities include two independent components: internal and external audits.

5.8.1 Field Performance and System Audits

Internal Field Audits

Internal audits of field activities, including sampling and field measurements, will be conducted by the BERA Investigation Manager or a designated alternate. Additional team members may also be present during various phases of the audits. These audits will be conducted to evaluate performance, verify that procedures are followed, and correct deficiencies in the execution of field procedures.

An internal field audit will be conducted at least once at the beginning of the site sample collection activities to verify that established procedures are being followed.

To verify compliance with established procedures and implementation of appropriate QA procedures, internal audits will involve the review and examination of the following: i) field measurement and sampling records, ii) instrument operation and calibration records, iii) sample collection documentation, iv) sample handling and packaging procedures, and v) chain-of-custody procedures. Results of field performance audits will be documented on a field audit checklist. If the first audit reveals significant deficiencies, one or more follow-up audits will be conducted to verify that QA procedures are maintained throughout the remainder of the investigation.

5.8.2 Laboratory Performance and System Audits

Internal Laboratory Audits

Internal system and performance audits at the analytical laboratory will be the responsibility of the Laboratory QA Manager. The internal laboratory system audit will be conducted on an annual basis, and the internal lab performance audit on a quarterly basis. Performance and systems audits for sampling and analysis operations will include on-site review of laboratory quality assurance systems and on-site review of equipment for calibration and measurement techniques.

External Laboratory Audits

One or more external laboratory audits may be conducted by the U.S. EPA Region 6 Project Coordinator. External laboratory audits will be conducted at the discretion of the U.S. EPA Region 6 Project Coordinator. External lab audits will include, but not be limited to, review of laboratory analytical procedures, laboratory on-site audits, and/or submission of performance evaluation samples to the laboratory for analysis.

5.9 CORRECTIVE ACTIONS

Corrective action is the process of identifying, recommending, approving and implementing measures to counter unacceptable procedures or poor QC performance which can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation and data assessment. All proposed corrective actions should be documented as well as the steps taken to implement the corrective action. Corrective action should only be implemented after approval by the Project Manager or his designee. If immediate corrective action is required, approvals secured by telephone from the Project Manager should be documented.

For noncompliance problems, a formal corrective action program will be developed and implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the Project Manager. If the problem is related to an analytical procedure affecting the quality of data produced, this information will be promptly communicated to the Analytical Lab Project Manager, the Project Manager and the QA Manager. Implementation of corrective action will be confirmed in writing through the same channels.

Any nonconformance with the established QC procedures will be identified and corrected in accordance with this QAPP. The Project Manager, or his designee, will issue a nonconformance report for each nonconformance condition and include a copy of this report in the project's files.

5.9.1 Field Corrective Action

Corrective action in the field may be needed when the sample program is changed (i.e., more/less samples, sampling locations or frequencies other than those specified in the WP or FSP) or when sampling procedures and/or field procedures require modification due to unexpected conditions. In general, the field team may identify the need for corrective action. The field staff, in conjunction with the field team leader, will recommend a corrective action. The Project Manager will approve the corrective measure, which will be implemented by the field team. It will be the responsibility of the Project Manager to ensure the corrective action has been implemented.

If the corrective action will supplement the WP or FSP, using existing and approved procedures in the QAPP, corrective action approved by the Project Manager will be documented. If corrective actions result in less samples, alternate sampling locations, etc., which may cause project QA objectives not to be achieved, it will be necessary that all levels of project management concur with the proposed action.

Corrective action resulting from internal field audits will be implemented immediately if data quality would be adversely affected due to unapproved or improper use of approved methods. The QA Manager will identify deficiencies and recommend corrective action to the Project Manager. Implementation of corrective actions will be performed by the field team under the direction of the Project Manager.

Corrective actions will be documented in the field notebook or field forms. No staff member will initiate corrective action without prior communication of findings through the proper channels. If the actions taken are insufficient to correct the problem identified, work may be stopped by the Project Manager. If at any time a corrective action issue is identified which directly impacts the project objectives, the Project Coordinator will be notified immediately.

5.9.2 Laboratory Corrective Action

Corrective actions in the laboratory may occur prior to, during or after initial analyses. As such, the initial analyses must be performed quickly enough to allow time for reanalysis within the

required holding time. A number of conditions, such as broken sample containers, may be identified during sample login or just prior to analysis. The Analytical Laboratory Project Manager will notify the QA Manager of such conditions prior to analysis. Following consultation with lab analysts and section leaders, it may be necessary for the Analytical Laboratory Project Manager to approve the implementation of corrective action. Some conditions that may trigger corrective action or optional procedures during or after analysis include dilution of samples, sample reanalysis when certain quality control criteria are not met, etc.

Laboratory personnel are alerted that corrective actions may be necessary if:

- QC data are outside the control limits for precision or accuracy;
- Sample results are outside the instrument calibration range;
- Laboratory method blanks contain target analytes above acceptable levels;
- Deficiencies are detected during internal or external audits or from the results of performance evaluation samples; or
- Inquiries concerning data quality are received.

The following specific instances require laboratory corrective action:

- The laboratory method blanks contain target analytes above the MQL and any associated sample contains the analyte at a concentration less than five times that in the blank.
- The LCS recovery is less than 10% for any organic target analyte or 30% for any inorganic analyte.
- The LCS recovery is outside the control limit for more than 1/2 of the target analytes for multi-analyte analyses such as PAHs.
- The surrogate recovery is less than 10% for any single surrogate.
- The MS recovery is less than 30% for any inorganic analyte.
- The internal standard area is less than 25% (i.e., -75%) of that in the midpoint standard for any single internal standard.

The corrective action shall include reanalyzing (and extracting or digesting, as applicable) the affected samples and/or immediate notification of the QA Manager.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the analytical procedures for possible errors, checks the instrument calibrations and performance, etc. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor or Analytical Laboratory Project Manager for further investigation. Once resolved, full documentation of the corrective action procedure is filed. These corrective actions are performed prior to release of the data from the laboratory. All corrective actions associated with sample analyses for this project will be documented and reported in the sample package narrative.

5.9.3 Corrective Action During Data Validation and Data Assessment

The need for corrective action may be identified during either data validation or data assessment. Potential types of corrective action may include re-sampling, reanalysis of samples, or reprocessing of the sample data. These actions are dependent upon the ability to mobilize the field team and whether the data to be collected are necessary to meet the required QA objectives. If the QA Manager identifies a corrective action situation, it is the Project Manager who will be responsible for approving the implementation of corrective action. All corrective actions of this type will be documented by the QA Manager.

5.10 QUALITY CONTROL REPORTS

5.10.1 Laboratory Data Report

Laboratory data reports contain the results of all specified QC measures identified in Section 5.5, including but not limited to equipment blank, filter and reagent blanks, field blanks, laboratory duplicates, laboratory control standards, calibration, and matrix spikes. For chemical analyses, this is generally considered a Level III data report (see section 2.7.4 of RI/FS QAPP). This information is reviewed by the QA Manager and compared to the pre-specified acceptance criteria to determine acceptability of the data before forwarding to the Project Manager.

5.10.2 Reports to Project Management

The Field Supervisor will report to the Project Manager daily following each field monitoring event. A brief written report will be sent via e-mail to the Project Manager that documents any problems, delays, or corrective actions that may be required or that may affect the subsequent

sampling efforts. The report will also include a brief synopsis of the work conducted during the field monitoring event.

5.11 DECONTAMINATION PROCEDURES

Site personnel will perform decontamination in accordance with PBW SOP No.13: Equipment Decontamination, and the applicable SOPs for sampling sediments (RI/FS Field Sampling Plan, PBW, 2006b). Following sediment sample collection, the empty sampler should be rinsed and decontaminated using water and an Alconox® or an equivalent detergent, and rinsed with deionized water. The sampler and associated equipment is decontaminated before use and between sample sites. In addition, the sampler will be rinsed with Site water before samples are collected. Equipment used for sample collection, sub-sampling, and sample mixing will be stainless steel or Teflon®.

5.12 MANAGEMENT OF INVESTIGATION DERIVED WASTES

Due to the nature of the investigation, investigation derived wastes are not expected to be produced. If any wastes are generated they will be managed in accordance with the procedures described in the RI/FS FSP (PBW, 2006b) (Section 7.0).

6.0 HEALTH AND SAFETY PROCEDURES

The overall health and safety objective is to perform the field tasks in a manner that minimizes the potential for accidents or injuries, and minimizes the potential for worker exposure to hazardous chemicals. Details of the health and safety procedures are provided in the Site-Specific Health and Safety Plan (HSP) (PBW, 2005), dated August 17, 2005.

The HSP applies to the field activities described in this FSP that will be performed during the RI/FS at the Site. The HSP was prepared to comply with the requirements of 29 CFR 1910.120 (b)(4). The primary purpose of the plan is to provide the results of a hazard assessment conducted for the prescribed work tasks, and the health and safety requirements and protocols that will minimize hazards to site workers.

A copy of the HSP will be kept on site at all times during field activities. All personnel will complete the Safety Compliance Agreement provided in Appendix A of the HSP. Other health and safety documentation are detailed in the HSP.

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